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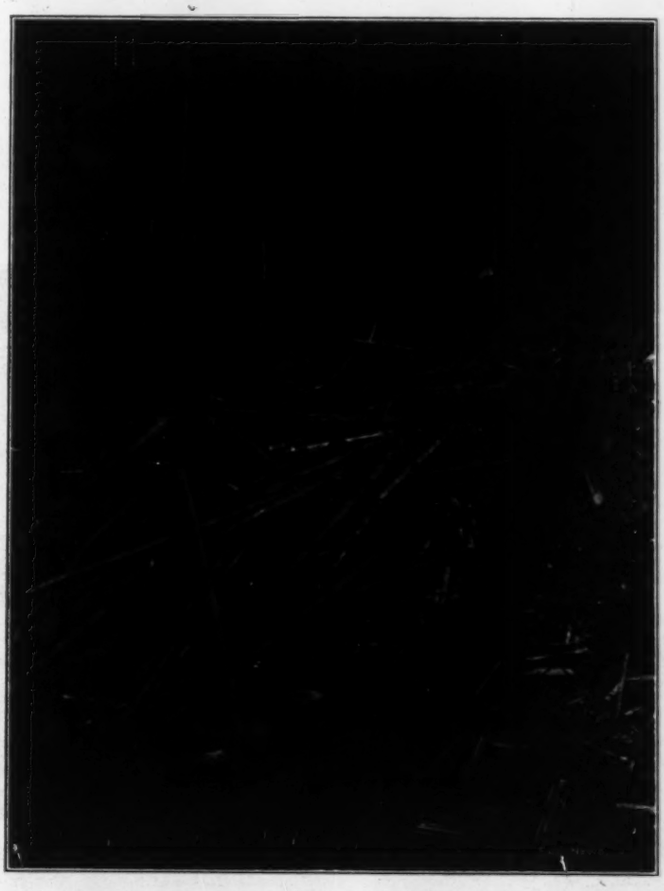
The Cedar River Power Development of the City of Seattle, Washington.

By LOUIS P. ZIMMERMAN.*

GENERAL DEVELOPMENT.—The City of Seattle, Washington, recently completed what is probably the largest municipal hydro-electric plant in this country. This development has been possible on account of the control of Cedar Lake, Cedar River and their tributaries for the municipal water supply. Seattle is only some 45 miles from the Cascade Mountains and in the foothills of this range has obtained an unlimited water supply of excellent quality. The site chosen by the city engineer is the drainage area of the Cedar and Rex Rivers and the numerous small tributaries, shown in Fig. 1. The Cedar River water shed controlled by the City of Seattle comprises about 125 square miles reaching to the summit of the Cascade range and surrounding Cedar Lake with its tributary streams. Cedar River flows in a northwesterly direction above the lake and westerly below it. At the extreme eastern end of the water shed is Silver Tip, a mountain rising to an elevation of 6,000 ft. On its western slope is the source of Cedar River. The northern slope was the headwaters of the Snoqualmie River, and on the eastern slope are the headwaters of the Yakima.

Cedar Lake is about 26 miles west of the summit of this mountain and is fed from the south by the Rex River which drains a large part of the territory north of the Northern Pacific R. R., between Hot Springs and the Stampede Tunnel. Cedar Lake is crescent shaped, about three miles long, and three-quarters of a mile wide, with an area of 1,260 acres and a normal elevation of 1,530 ft. It is of glacial origin, being formed by a moraine dam a mile and a half long and a mile and a half wide, dropped across the end of a ragged and rocky canyon basin. The area immediately surrounding the lake is rocky and precipitous so that, following a storm, there is an immediate run off of 50% in the rainfall. The remainder finds its way to the lake by percolating through the rocky soil. No soil or loam is carried in suspension. A heavy wooded growth, principally fir and hemlock, covers the sides of the hills and mountains farther back, so that the run off there is more uniform throughout the year. The annual rainfall, of some 112 ins., finds its way to the lake rather quickly on the lower levels. On the higher levels, the moisture falls as snow and is held frozen until the warm summer months. The rainfall is heaviest between Nov. 1 and July 1, during which time the run off is mainly from rains and from snow melted by chinook winds. Between May and July, the run-off is entirely from snow, on the mountain sides, melted by the warm weather.

The water shed at Cedar River is peculiarly suited for power development from a water supply in one way. The sewage of the camp near the power plant goes to the adjacent water shed of the Snoqualmie River by a sewer 1,400 ft. long, laid 9 ft. under ground and sloping with a 1% grade to a cesspool 3 ft. under ground that opens out into the Snoqualmie River water shed. The sanitary arrangements of the various construction camps of the city of Seattle, and of the Chicago, Milwaukee and St. Paul R. R., which enters this drainage area, have been arranged after approved practice, to prevent pollution of the water supply.*



CEDAR RIVER PIPE LINE CROSSING A CANYON IN CUT AND ON ROCK-FILLED CRIB.

About three miles below Cedar Lake, a hydro-electric power plant of an ultimate capacity of 20,000 HP. uses a part of the water of the Cedar River. Some 12 miles below, to the west and about 28 miles from Seattle, is the intake for the city water supply. From here water is now taken to the city through two wood pipe lines, 42 and 44 ins. in diameter, respectively. The older of these lines has been in use since 1901. Two new wood pipe lines, 52 and 60 ins. in diameter, are under construction.

At the lower end of Cedar Lake the river has a width of some 150 ft. and here a temporary wooden-crib dam has been built with its weir 13 ft. above the old lake level. Eventually a large concrete dam will be built 7,500 ft. farther down the canyon and during that construction the present dam will serve as a cofferdam. The river channel, at this wooden dam, is 75 ft. wide. The crib work is built on the loose gravel of the natural moraine dam across the canyon. This gravel is formed here to a depth of 63 ft.

An excavation for the foundations was carried down 13 ft. below the river bed, extending 110 ft. with the stream and 125 ft. across. This portion was floored with 14 × 14-in. timbers, cut on the ground by a saw mill erected at the dam site. The floor was spiked and drift bolted across mud sills laid at right angles to the stream and butted into the sand and gravel banks. Over the flooring a timber crib was built 26 ft. high with a roof-shaped top acting as a weir. As the banks of the stream consisted of loose gravel the cribs were carried into the shoulders of the moraine on the north and south sides, so that the crib work is 310 ft. long and the dam itself only 180 ft.

At one end of the dam is the intake, where the wood pipe lines are taken out through a special wood crib on the south bank. From the intake to the power-house is a distance of 17,000 ft. The water flows 16,000 ft. through wood pipe and finally is taken to the power units through three steel penstocks, each 48 ins. in diameter. A final fall of 500 ft. in the last 2,000 ft. of run gives the necessary head.

PIPE LINE.—Formerly one 48-in. wood pipe line supplied water to two Pelton wheels in the old plant. To supply the two new units of 4,000

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[*The project of running the railroad line along Cedar River aroused much discussion on the pollution danger as noted in Engineering News at the time. In our issue of Aug. 30, 1906, p. 238, is given the report of Mr. J. W. Alvord. In the issue of Dec. 27, 1906, p. 684, is given the report of Mr. J. R. Freeman and an address by Prof. W. T. Sedgewick.—Ed.]

KW. each, a second wood pipe, 68 ins. in diameter has been constructed, generally paralleling the course of the old pipe. At a point 1,000 ft. from the power-house the new pipe is divided into two 48-in. riveted steel penstocks leading to the turbines. Below this division point the pressure is greater than is considered safe to carry on wood pipe. The grade of the new pipe was kept below a line, whose slope was 4 ft.

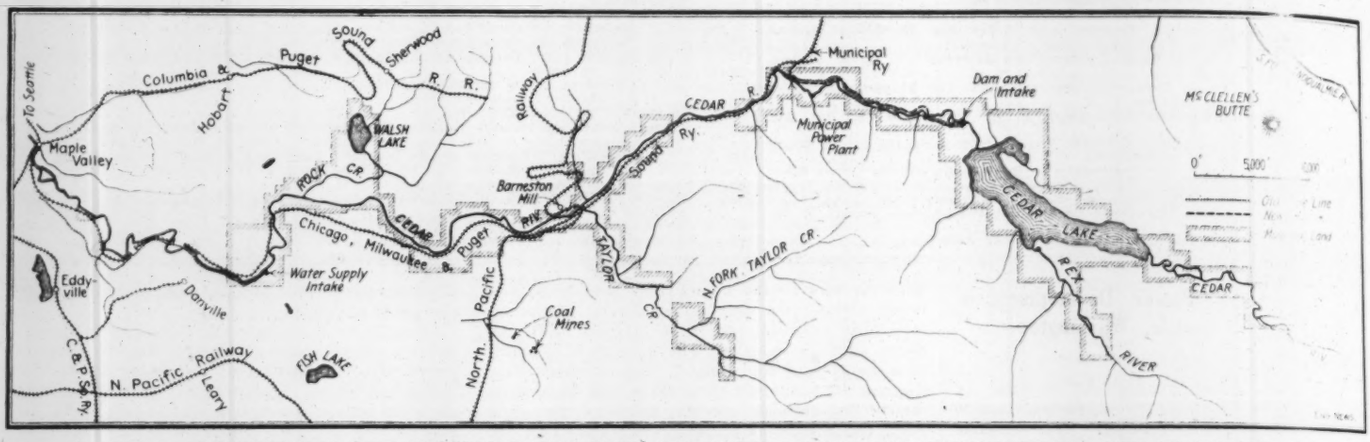

FIG. 1. DRAINAGE AREA OF THE CEDAR RIVER POWER AND WATER-SUPPLY DEVELOPMENT OF THE CITY OF SEATTLE.

on 1,000, drawn from the top of the pipe at the intake to the beginning of the last slope above the power-house. It was necessary to cross and recross the old pipe line six times between the dam and the power-house.

One of these crossings is shown in Fig. 2. At all of these places provision has been made to give a steeper gradient to the old pipe line which now drops 2½ ft. on 1,000. Between the floor of the power-house and the top of the weir is a difference of elevation of 603 ft., which gives an operating head of about 600 ft. or 260 lbs.

The new line paralleled the old one, in general, the center lines being 11 ft. apart. The old line crossed Cedar River three times, being carried under the bed in each case. A new line was located on the north bank for 3,000 ft. of the new pipe, eliminating the two lower crossings for the new work. As a minimum radius of curvature equal to 60 times the pipe diameter is considered the economical limit on such pipe, this demanded a minimum radius of 360 ft. with the new line where 173 ft. was permissible with the old one. There were five places where sharp curves could not be avoided and special steel elbows were used. Three of these were 45°, one was 90° and one 54°. The 90° elbow is in the upper part of the line and will be eliminated when the permanent dam is put in.

All staves in the new pipe are sawed from 2½ × 8-in. stock with finished dimensions of 2¼ × 7½ ins. Live yellow fir in lengths of from 10 to 30 ft. was used, free from loose or unsound knots of any size, with sound knots not over 1 in. in diameter and not more than one knot in every four linear feet. Small pitch pockets not extending through the piece, sap wood on the inside of the stave only, and for not more than one-half the thickness of the piece, were allowed.

FIG. 2. CROSSING OF 48- AND 68-IN. WOOD-STAVE PIPES.

The staves were milled during the early part of the winter (1907-1908), were delivered to the material yards and were stacked in piles with strips to separate the layers. They remained in the yards until delivered to the work when they were replied with strips and roofed over to protect them against rain. As used, the staves were sorted and distributed along the line. All material furnished under these conditions gave good results.

The maximum band spacing for the lowest pressure was 12 ins., as this was necessary for holding the pipe together. For heads up to and including 110 ft., ⅝-in. mild steel bands were used; for heads between 110 and 220 ft., ¾-in. band, and heads above 220 ft., ⅞-in. The spacing was determined from the formula:

$$S = \frac{F}{R\,P}$$

where S = spacing in inches.

F = safe tensile strength.

$$= \frac{\text{Area of band} \times 60{,}000.}{4}$$

R = inside radius of pipe in inches.

P = pressure in lbs. per sq. in.

The bands were made in two sections, one section having two button heads and the other having two 6-in. cold rolled threads. Malleable shoes of special design received one button and one threaded end.

For building up the staves into pipe, two outside forms of 2-in. gas pipe were used, bent to U-shape, to fit the outside of the finished pipe. Inside, a helical form of 2-in. gas pipe was used. The first section of pipe line was started by building up inside two outside forms from the bottom to a point above the center of each side. The inside forms were then put in place and the staves put around over the top. The section was then ready for banding. After the first section was completed only one outside and one inside form were necessary, as the erected section of the pipe took the place of one set of forms. The ends of abutting staves were joined by steel tongues placed in saw cuts. After the section has been banded over the joints, the staves were driven to a tight contact with heavy wood mauls. The combined depth of the saw cuts being about 1¼ ins., the tongues were firmly embedded in the end grain of each stave, making a practically water tight joint. The staves were milled with a slight bead on one edge, so that when they were drawn town tight by cinching up the bands, a perfect joint was formed by the beading.

In banding, care was taken to have all the bands in nearly uniform tension. They were tightened at least twice between the first cinching up and the final adjustment, which is done at least 24 hours after erection. During the first and second cinchings, the bands are hammered to fit the pipe snugly. The final cinching is done by two experts working simultaneously. These men put the final tension on the bands with 16-in. rachet wrenches and judge the band tension by the sound the band produces when struck with a test hammer.

Fig. 3. Steel Breeches, Changing 68-In. Wood-Stave Pipe to Two 48-In. Steel Penstocks.

Provision for blow off and for draining the pipe is made by 6-in. pipes. These pipes are attached through special castings held against the wood-stave pipe by bands and made tight by sheet-rubber gaskets. Relief air valves on the summits of the line are similarly attached.

In depressions the pipe line was carried on timber cribs filled with broken rock, as it was feared that a timber trestle might be destroyed by forest fires. The cribs were built from green fir

or cedar cut on the spot, and the pipe itself was held on sills by hewn saddles. The timbers were clapped to fit and fastened with ⅝-in. drift bolts. The highest crib raises the pipe line about 15 ft.

Wood-stave pipe was decided upon for the original line because it could be placed at a total cost of about half that of iron or steel. It was much easier to bring the parts for the wood pipe in small quantities through the wilderness surrounding Cedar River and to build the pipe on the ground. Good mountain roads had been built through the forest up to the top of the canyon above the old line and for the new work it was only necessary to continue branches to portions of the projected new line remote from the old. The staves were cut about five miles from the work and hauled by tramways to points from one to three miles from the work. The remaining haul over a maximum grade of 8%, was done with teams, a four-horse team hauling about 1,500 ft. of staves, board measure. Generally, the points of delivery were about 150 ft. above the pipe line on the bluff, "toboggans" being used to slide the material down to where it is used.

Along the pipe line itself no hauling was possible, the material being packed along by the men as the cheapest means of transportation. The steel pipe for the double penstock was brought in over the railroad of the North Bend Lumber Co., and the municipal railway leading to the power plant. The pipe was hauled into place on the slope above the power house on skids with block and tackle, worked by a donkey engine.

The old wood pipe has been in service some six years and shows no signs of deterioration. Sufficient head has been maintained, so that the penetration of water from the inside of the staves keeps them nearly saturated and rot bacteria do not propagate.

The pipe line here described was erected under the supervision of Mr. J. L. Stannard, Assistant City Engineer, in charge of the water department. All the work, except milling the staves, was done by the city by day labor.

POWER STATION.—This hydro-electric station supplies current for the street lamps in Seattle and for a number of private customers as well. The work described in this article has been made necessary by the increased demands for power, both by the city and by individuals. The plant as formerly existing contained two 1,250-KW. generators, driven by two impulse wheels. These wheels never gave the satisfaction expected since an efficiency of less than 60% was the best ever obtained. It was decided to use two 4,000-KW. high-head turbines in the extension design, and the Francis type was chosen in open competition.

The layout of the plant has been made very compact, as will be seen in Figs. 6 and 7. On one side of the station is a high hill, and on the other side is Cedar River. Between the powerhouse and the river is an extension of the municipal railway. Material can be brought to the site on flat cars and skidded directly into the station, where it can be picked up by a traveling crane. The additions to the main buildings were put on each end. In the larger one, toward the hill, are the two units. The smaller addition houses a small machine shop. At the back side of the generator house, and opening from it, is the old high-tension, switch room. A little to one side is a new stone high-tension switch house, at which the transmission lines end. The step-up transformers are located in two parallel buildings between the switch house and the generator building. This latter, the main building, is built on solid rock. The first 5 ft. of wall is of rock and upon this rests the wooden superstructure. Foundations for the machines are of concrete resting on solid rock, it being necessary in some cases to drill holes in the rock for the anchor bolts. The pit into which the draft tube discharges is excavated from solid rock, with the waste way or tail race walled with masonry laid in concrete mortar and with the floor paved with concrete.

The new generating units are alike, being 4,000-KW., 2,300-volt, three-phase Westinghouse generators directly connected to 42-in. Victor turbines. Each turbine is equipped with a synchronous by-pass, a remote-control Lombard governor, a relief valve and a tachometer. Including the regulator, gate mechanism and thrust bearing each turbine has a floor space 15 × 16 ft. Each unit is built with three bearings; one outside for the generator; a middle one between turbine and generator and a thrust bearing on the turbine end.

The entire plant is designed in duplicate so far as has been possible. There are now two pipe lines and three penstocks. Either pipe line is large enough to carry most of the normal load during an emergency. Cross-connection between the penstocks allow any combination of penstocks and pipe lines. The generators are connected to two separate sets of station bus bars running in separate concrete compartments. All four generators may be run in parallel on either set of bus bars with three banks of transformers which can be connected to an old or a new transmission

FIG. 6. THE MUNICIPAL POWER PLANT AND CAMP OF THE CITY OF SEATTLE, ON THE CEDAR RIVER.

FIG. 4. PENSTOCK CROSS-CONNECTIONS, CEDAR RIVER POWER PLANT.

FIG. 5. A STEEL ELBOW AT 90° CURVE IN A 68-IN. WOOD-STAVE PIPE.

line. A duplicate design of the Seattle substations has also been maintained to insure continuity of service so far as possible.

In the power station the control has been made as nearly automatic as possible in a plant of this type. The different pieces of control apparatus are actuated from a 125-volt direct-current control and exciting circuit which is supplied by a small independent water-wheel unit. Automatic synchronizing of the generators has been used, although provision has been made for hand synchronizing in an emergency. As a help to the station operators, at the switchboard all exciter-circuit connections are finished in nickel, 2,300-volt connections in copper and 60,000-volt in brass.

Two water resistances have been provided for furnishing an emergency load in case of failure of the control apparatus and racing of the machines.

Nine 1,500-KW. water-cooled transformers are set in banks of three, star connected with each bank in a separate concrete compartment. All switches for the transformers are set on 6 × 6-in. wooden beams above. Connections are carried out of the buildings through 14-in. tiles, projecting 2½ ins. on both sides of the walls. The conductors are brought to insulators on the inside and outside of walls. Connections are completed by ⅞-in. copper bars covered with 3½ × 3-in. clay tile, having the ends hermetically sealed to exclude moisture.

The new transmission line was designed for 60,000 volts. The old one is worked at 38,000. The two lines are parallel for the most of the run to Seattle. Since this distance is largely through a virgin forest of trees 100 and 200 ft. high, it has been necessary to fell all the timber for 150 ft. on each side of the right of way. Both lines are the equivalent of 0000 B. & S. gage, of hand-drawn, stranded, copper wire, are spaced as an equilateral triangle of 84 ins., and stretched in spans of from 400 to 750 ft. The poles felled on the ground are mostly of the best cedar, 40 to 60 ft. high and 10 to 18 ins. in diameter at the butt.

A simple horn-type lightning arrester was tried, but severe grounds resulted so that it was necessary to use two horn gaps with a water resistance to ground. The water resistance is furnished by a column of water flowing through 25 ft. of 2-in. fiber pipe. This arrester has proven satisfactory.

The design and construction has been carried out under the general supervision of Mr. R. H. Thomson, Am. Soc. C. E., City Engineer. All construction was under the direct charge of Mr. J. L. Stannard, Assistant City Engineer, to whom the author is indebted for much of the information here presented. The electrical part of the plant was planned by Mr. J. D. Ross, Assoc. Am. Inst. E. E., Electrical Engineer of the City. Mr. L. B. Youngs is Superintendent of Light and Water and directs the operation of The Cedar River Works. To these gentlemen also the writer is indebted in writing this description.

Rainfall and Runoff on the Croton Drainage Area, New York Water-Supply, 1908-9.

By ALFRED D. FLINN,* M. Am. Soc. C. E.

Knowledge of rainfall and runoff is of fundamental importance to water-works engineers, and so it is assumed that a few additional notes about them for a well-known watershed will be of interest to many readers of Engineering News.†

In 1906, the rainfall was 47.54 ins.; in 1907, 57.30 ins., and in 1908, 42.26 ins. Last year was the driest in the past 13; the rainfall in 1895 was 40.58 ins. The average for 41 years has been 49 ins. During the 13 years since 1895, 7 have had over 50 ins., some of them much more; 1908 named was 5.18 ins., almost as great as the difference in rainfall, 5.56 ins. No corresponding period has been so dry as the last seven months of 1908 since 1880, when the runoff for the last seven months was 1.90 ins.

Cross River reservoir was filled and put into service in 1908, adding 10,923 million gallons to the reservoir capacity on the watershed and raising the total to 88,751 million gallons. In spite of this the Croton reservoirs were drawn very low late in the winter of 1909, the water in storage being reduced to a minimum of [illegible] million gallons, a depletion of nearly 51 [illegible] million gallons. Water began to flow over the waste weir of the New Croton dam April 24, 1909, although two large reservoirs whose tributary portions of the watershed are relatively small were still far from full, needing 2,500 million gallons to fill them. In one of these the water is still (June 2) about 4 ft. below the spillway crest. There are now about 87,000 million gallons in storage; in November, 1905, there were only 18,700 million gallons; in December, 1906, only 31,400 million gallons; in May, 1908, all the reservoirs were full, but have not been since.

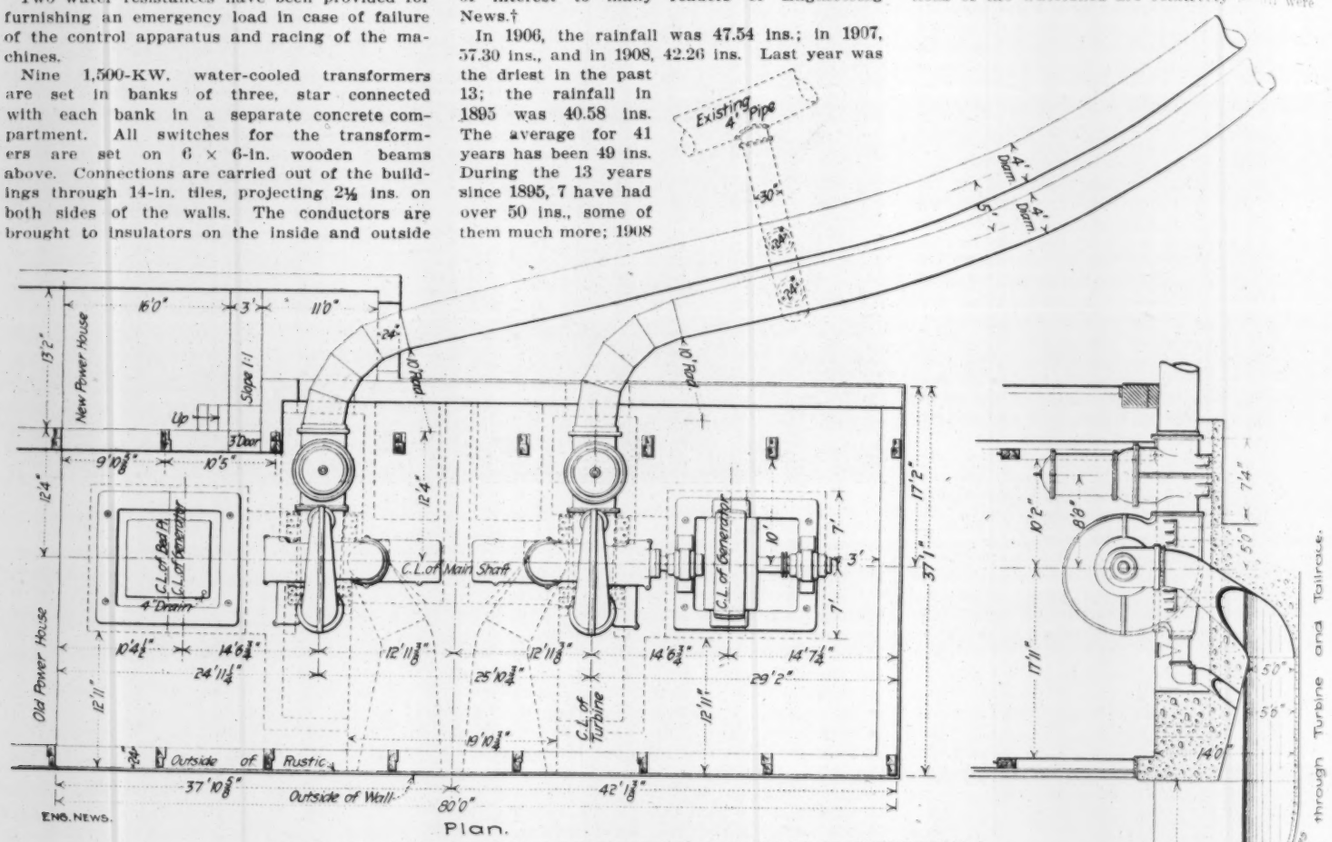

FIG. 7. PLAN AND SECTION OF CEDAR RIVER POWER-HOUSE EXTENSIONS.

Water flowing over the waste weir of the New Croton Dam has been interpreted by the daily press and others a needless loss to the city. Such persons have failed to observe that such overflow has followed periods of heavy and concentrated precipitation, and, perchance, do not know that from April 15, 1905, to Nov. 6, 1907, an interval of 31 months, and again from June 7, 1908, to April 24, 1909, a period of 10½ months, no water whatever flowed over the New Croton Dam. As mentioned above, when water last began flowing over the waste weir, two large reservoirs were still far from full. Water ceased to flow over the dam May 20, 1909.

The consumption of Croton water is now, in these current wet months, at a rate of over 300 million gallons per day. It has averaged for a month as high as 345 million gallons per day, in recent years.

But for water-supply purposes it is not so much the rainfall that must be known as the proportion of the precipitation which can be collected into the streams and reservoirs. In 1906, the runoff from the Croton watershed was 20.51 ins.; in 1907, 29.53 ins., and in 1908, 19.90 ins., which last was less than for any year since 1895, when the runoff was 15.81 ins. For 41 years the runoff has averaged 49% of the precipitation, or 24 ins. During the 13 years since 1895, 7 have had over 24 ins. runoff. The last seven months of 1908 had a total runoff of 2.87 ins.; for the same period the 41-year average was 8.80 ins. From 1869 to 1886, the runoff averaged 20.70 ins., and from 1887 to 1908, 25.88 ins. The average difference in runoff between the dry and wet periods just fell 6.74 ins. below the average. The last seven months of 1908 totaled only 18.55 ins.; the average for the same months for 41 years was 29.30 ins. The average annual rainfall for the 18 years from 1869 to 1886, which were prevailingly dry, was 45.87 ins.; for the 22 years from 1887 to 1908, which were prevailingly wet, it was 51.43 ins. From May 1, 1907, to April 30, 1908, 61.61 ins. of rain fell. During the first five months of 1909, 25.04 ins. of rain have fallen, and 7.57 ins. fell in April.

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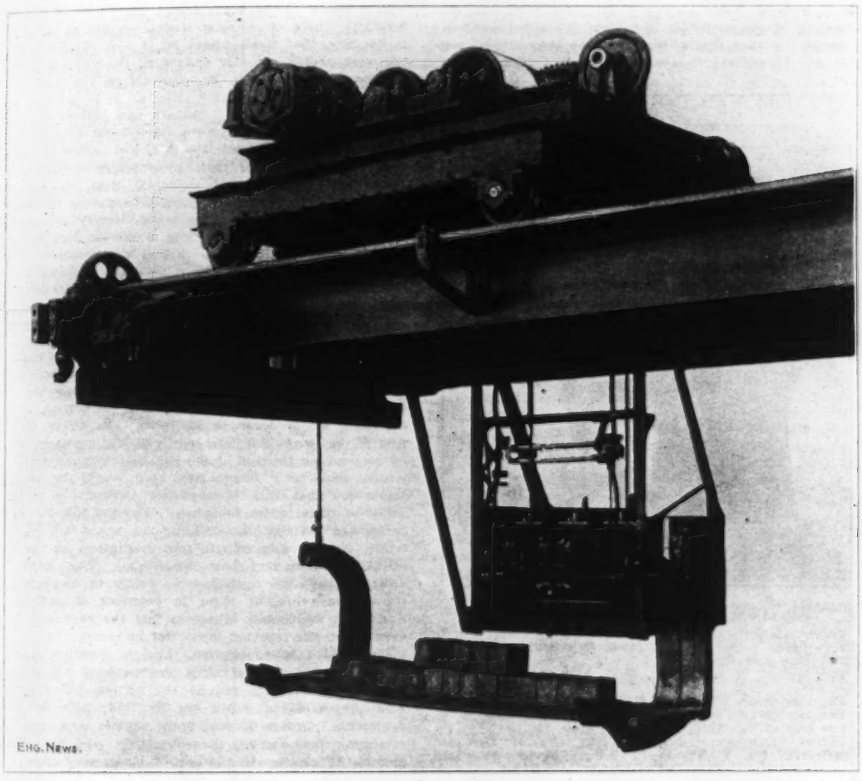
†Feb. 6, 1908, a lengthy article on the rainfall, runoff and development of Croton watershed was published; these notes are intended to bring a few of the lines of that article down to date.

Traveling Cranes Equipped with Scales.

In the handling of materials at warehouses, manufacturing plants, etc., it is often necessary to weigh the material, and where there is much work of this kind it is very desirable to effect it as simply and with as little trouble or delay as possible. Scale cars for weighing ore, etc., for blast furnace charges are very generally used. We illustrate herewith a scale crane which consists of a traveling crane equipped with scale apparatus for weighing the loads carried.

The machine is operated entirely by electricity, and is shown equipped with an open-side platform for carrying long pieces, such as steel rails, bars, rods, etc. The platform can be made, of course, to suit the material to be handled. The scales are supported from the frame of the trolley, and the hoisting mechanism is mounted on an independent steel framework. By the simple movement of a lever, the load is transferred to the knife edges of the scale or to the trolley



ENG. NEWS.

5-TON ELECTRIC TRAVELING CRANE WITH SCALE EQUIPMENT.
Whiting Foundry & Equipment Co., Harvey, Ill.; Makers.

frame, as desired. There are three beams: two scale beams with self-recording poises, and one tare beam. This arrangement enables the scale weights of different materials to be obtained easily and with accuracy.

This type of crane is useful in loading material for shipment, checking invoiced weights, etc. With ordinary cranes in such work the weighing is sometimes done by a scale device hung upon the crane hook, but this is often inconvenient and takes up head room which is sometimes of importance. The scale crane has been patented, and is built by the Whiting Foundry & Equipment Co., of Harvey, Ill. The cut shows one of six 5-ton cranes for the new warehouse of the Scully Steel & Iron Co., at Chicago. They have a span of 37 ft. 10¾ ins., and are operated by alternating current.

THE LAKES-TO-THE-GULF DEEP WATERWAY project for a 14-ft. deep channel from Chicago to New Orleans has been reported on by a Board of Engineers, and the report is highly unfavorable. The total estimated cost is $158,687,462 for the whole distance, and grave doubt is expressed as to the practicability of the project, even with that expenditure.

Industrial Accidents and Employers' Liability.

A number of American states have at last become aware of the fact that this country is far behind the other leading industrial countries of the world in safeguarding the interests of employees liable to injury or death through the nature of their daily work. This awakening is taking a variety of forms, but we shall concern ourselves here only with employers' liability for compensation in case of injury or death due to accidents to workmen.

Commissions to study the subject just mentioned have been created in Massachusetts, Illinois, Wisconsin, Minnesota and California. The New York Legislature at its last session also provided for the creation of a similar commission, and the New York Bar Association has appointed a special committee to study the subject.

A valuable pamphlet on employers' liability has just been published by the New York Branch of the American Association for Labor Legislation. The pamphlet consists of a portion of a book on work accidents which is to be published soon by the Russell Sage Foundation. It gives the results of an investigation at Pittsburg, made on behalf of the Pittsburg Survey by Miss Crystal Eastman, a member of the New York Bar.* We reprint the greater part of the pamphlet, as follows:

The Facts.

The following study of the effects of industrial accidents in the homes of the workers is based upon a personal investigation of the results of one year's fatalities and 300 injuries in the great steel district of Pennsylvania. These accidents occurred in the mills, in the mines, on railroads and in many other places.

Of the 526 workers killed in Allegheny County during one year, 258, almost one-half, were married men regularly supporting their families, and 3 were women contributing to the support of others. The other 265 were single men of all ages from 13 to 65, 9% of whom were the sole support of a family, 10% were the chief support, and 43% regular contributors. Thus while 19% of all the deaths left no private economic problem to be faced, considerably over half of them meant the sudden cutting off of the chief support of a family.

Was the burden of lost income left altogether upon these families, or did the employers make it up to them? This is our first question, and we have figures with which to answer it.

Out of 355 cases of men killed in a year's industrial accidents all of whom were contributing to the support of others and two-thirds of whom were married, 80 of the families left received not one dollar of compensation from the employer; 113 families received not more than $100, a sum which would cover reasonable funeral expenses, but would not replace any of the lost income; 61 families received something over this $100, but not more than $500. In other words, 57% of these families were left by the employers to bear the entire income loss, and, granting that all the unknown amounts would be large and that all the suits pending would be decided for the plaintiff, only 26% received in compensation for the death of a regular income provider, more than $500,—a sum which would approximate one year's income of the lowest paid of the workers killed.

The proportion of the loss borne by employers in injury cases does not differ greatly from that in death cases. Thus, out of 288 injury cases: Of the married men, 56% received no compensation;† of single men contributing to the support of others, 68% received no compensation; single men without dependents, 80% received no compensation.

Of 6 men totally disabled for life (one lost an arm and a leg, one is paralyzed, and four will walk on two crutches for the rest of their lives), three received no compensation, one $30, one $125, and one $365.

In 27 cases where men were partially disabled for life, and their earning power reduced on an average 29%, compensation was as follows: 12 received no compensation; 7 received $100 or less; 6 received $101 to $500; 2 received over $500.

For the loss of an eye in eleven cases compensation was as follows:

Three men received nothing; 1 man received $48; 2 men received $50 each; 1 man received $75; 1 man received $100; 2 men received $150; 1 man received $200.

For the loss of a leg in 6 cases compensation runs from nothing to $225, but in most of these cases the cost of an artificial limb is included in the compensation stated. Out of 10 cases of men who lost two or more fingers, 6 received nothing in compensation, one $15, two $100 each, and one, for the loss of three fingers, $250. Compensation in these 10 cases averages $19 a finger.

Figures are wearisome and confusing. Perhaps it will be sufficient to note and remember that the proportion of cases in which no dollar of compensation was received from the employer to take the place of lost income, in case of both injuries and deaths, including both married and single men, is considerably over 50%. Thus, for the death of 55% of the married men and 68% of single men contributing to the support of others, no compensation above reasonable funeral expense ($100) was made; in the injury cases 56% of the married men, 69% of the single contributing men, and 80% of the non-contributing men, received no compensation.

This fact is significant enough for our present purpose. In over one-half of the cases of death and injury resulting from a year's industrial accidents in the Pittsburg District, the injured workmen and their families, the dependents of those killed, suffer the entire income loss.

There are only two grounds on which such a distribution of the loss can be defended: (1) On the ground that the men injured in the vast majority of these accidents of industry are themselves personally and solely responsible in causing the accidents by which they were injured; (2) on the ground that in all employments which involve danger, the workman's wage is large enough amply to cover his risk.

Causes of Work Accidents.

Let us consider for a moment the causes of industrial accidents. All would agree that some are unavoidable, some due to the employer's failure adequately to provide for safety, and some due to the carelessness of the victims themselves or their fellow workers. We should disagree about the proportions.

There has been no adequate and trustworthy study of the causes of industrial accidents in this country. The accompanying tabulation of responsibilities resulted from a study of 377 fatal accidents in the Pittsburg district. It is based upon the evidence given at inquests, statements made to the investigator by witnesses and fellow workmen, and, in 191 cases, the record of the accident kept by the employer.

INDICATIONS AS TO RESPONSIBILITY FOR INDUSTRIAL ACCIDENTS RESULTING IN DEATH.

Accident attributed	Number.	Per cent. of total.
Solely to those killed or their fellow workmen	105	27.85
Solely to employers or those who represent them in positions of authority	113	29.97
To both the above classes	60	15.91
To neither of the above classes	99	26.26
Total	377	100.00

*For announcement of the book named, when ready, address Charities Publication Committee, 105 East 22d St., New York.

†"No compensation" means no compensation for lost income. Hospital charges in 84% of the injury cases were paid by the employer.

It is not claimed that this is a tabulation of proved conclusions, but it has at least a certain negative usefulness in indicating that "95% of the work accidents" are not "due to the fault of the man that gets hurt," as is so commonly asserted and believed. Thus for 26% of these industrial accidents, according to all the evidence attainable, no one was to be blamed. Mining, railroading, steel-making, structural work and many other occupations are and must continue to be inherently dangerous trades.

Each one of those 113 accidents which make up the employer's 29% of responsibility, was not caused by some personal conscious failure on the part of the employer. Rather, all of those accidents can be laid to inadequacy in that part of the productive machinery which the employer furnishes, and for which he if any one is responsible. Thus some of these deaths were due to mistakes of incompetent or careless foremen, for which the employer is often only theoretically to blame. Some were due to defects which could not have been discovered, such as the breaking of chains from crystallization inside. But many were due to deliberate disregard for safety in the construction of plant and equipment (such as the absence of railings and guards, often amounting to a violation of the law). Many were due to defects which reasonably careful inspection would have discovered and immediate repair have rendered harmless. And seven were due to the regular employment of children in works or in surroundings that meant danger to them on account of their youth.

In the same way the 27% checked against the victim or his fellow workmen includes many for which the worker is not personally responsible. Thus of this 27%, 5% were due to ignorance, 3% to youth, 1% to physical weakness. This leaves 16 due strictly speaking to "carelessness." Even this 16% deserves analysis. A careful study of the accidents included under it reveals that some were due to an exasperating heedlessness for which there is no excuse. The great majority, however, were due either to inattention, or to what is commonly called "recklessness." For the inattentive it must be said that human powers of attention are universally limited, and in the case of men in dangerous trades they are very apt to be further limited by the conditions under which the work is done,—long hours, heat, noise, intense speed.

For the reckless workmen there is much to be said. Wise employers and superintendents, while they deplore this recklessness among their workmen, do not hold the men personally responsible for it. One superintendent said to me after telling several stories of rather astonishing recklessness, "Mind you, I don't blame the men. I'd do the same thing myself." There is a leaning toward recklessness in us all. How many of us will take the slow, hard, safe way of doing a thing if there is a quick easy way which is not too dangerous? Let this universal failing, if it is a failing—this tendency in us to take chances—be played upon by an environment of constant danger, as it is with the men in dangerous trades, and you have the reckless workman. If a hundred times a day our railroaders and iron-workers take necessary risks, it is not in reason to expect them to stop there and never take an unnecessary risk. Recklessness is part of the trade.

Not all accidents due to inattention and recklessness can be thus defended, but so long as dangerous trades are carried on as they are to-day, a majority of such accidents must be classed as unavoidable.

Certainly, the facts[1] brought out by this study of accidents do not uphold the contention that the vast majority of industrial accidents can be laid to the personal responsibility of the victims. Accidents occur in the course of an industry. If it were carried on slowly and carefully with safety as the first consideration of all concerned, there would be few accidents. Carried on as it is to-day in America, at a great speed, with large output and rapid accomplishment as the first considerations, there are many accidents.

"Wages Cover Risk."

We will consider now the second ground on which the present distribution of industrial accident losses might be defended; i. e., the ground that the workman's wage in all these employments which involve danger is large enough to cover his risk. Is it large enough? Here again we have figures:

WEEKLY EARNINGS OF MEN KILLED IN INDUSTRIAL ACCIDENTS.

Weekly Earnings.	Number.	Per cent.
Under $10	71	16
$10.00—11.99	71	16
$12.00—14.99	89	20
$15.00—19.99	158	36
$20.00—29.99	44	10
$30.00 or over	7	2
Total	440(2)	100

(2) In 86 cases earnings could not be ascertained.

Over half of these men (52%) were earning less than $15 a week. That much income, $2 a day for a seven-day week, is necessary, according to a recent careful study,[1] to maintain a meager standard of food, clothing and shelter in the Pittsburg district, for a typical family of five. On $15 a week it is possible, at the sacrifice of all recreations, to carry a small insurance at ordinary rates. But these men are many of them in the class of greatest risk. Their occupation which makes insurance especially necessary to them also makes insurance exceptionally high.

There are other ways in which we may show that wages do not cover risk. The simplest and most convincing is merely to call attention to the fact that an unskilled man who starts to work in a steel mill, begins at the wages of common labor in other occupations, although he may be put in a most dangerous place; and his wages are gradually raised, not as he goes into more and more dangerous work, but as he becomes more and more skilful and experienced. Hence at no time is his wage fixed by the danger of his occupation. "Wages cover risk," then is not the statement of a fact, but the statement of a convenient legal theory.

Considering the two grounds on which the present situation might be defended, we have found (1) that the workman injured is in but few cases personally responsible for the accident which causes his injury; and (2) that his wages are not adjusted to cover his risk. We can assert then without qualification that the distribution of the economic loss from industrial accidents revealed by this study,—which leaves the injured man and his dependents to bear the entire burden in over

Valuations Put on Men in Pittsburg.

Actual amounts paid as compensation by employers to 27 workmen permanently injured in Allegheny County, April, May and June, 1907.

For loss of an eye, $200, $150, $150, $100, $75, $50, $50, $48, 0, 0, 0.
For loss of an arm, $300, 0, 0.
For loss of two fingers, $100, $100, 0, 0, 0, 0, 0.
For loss of leg, $225, $175, $150, $100, $55, 0.
(From "Employers' Liability," by Crystal Eastman, Publication No. 1, New York Branch of the American Association for Labor Legislation.)

half the cases, and only in rare instances relieves them of an appreciable share of it,—is on the face of it unjust; it constitutes a wrong in the relations between employer and employee of sufficient seriousness to warrant special legislative adjustment.

Actual Hardships Resulting.

But we will not pause here, having shown that a grave injustice exists in the distribution of this loss. We must know what manner and measure of actual hardship this injustice brings to those who suffer it.

We were able to follow, for about eighteen months after the accident, the fortunes of 132 families of married men killed. In some cases there was no deprivation yet felt. Thus, four families to whom compensation of over $3,000 was paid, six families of middle-aged men of exceptionally high earnings who had left more than $3,000 insurance, had felt no hardship during the first year or two after the accident. But in the majority of the 132 families there had been a real struggle. [Details follow which we omit for lack of space—Ed.]

When a working man is injured, the problem of lost income is usually one of weeks instead of years, but while it lasts it may mean a more exhausting struggle with poverty than is caused by death of a wage earner. When a man dies as a result of injury there is at least one less consumer in the family. When a man is disabled by injury, the number in the family remains the same; and their situation is further complicated by having a sick man to feed and care for. An invalid whose recovery is delayed by the very conditions of increasing poverty and anxiety which his injury caused, and which his recovery alone can termina

The Injustice of It.

The lives of common people are apt to be full of disasters, little and big. In work accidents we have a peculiar kind of disaster by which, roughly speaking, only wage earners are affected and which fall upon them, in addition to all the disasters that are common lot. A special cloud always threatens the one of the worker in dangerous trades, because his work involves physical risk to him, and on his life strength depend the comfort and happiness of his family. What is his "work" then? Who chose it for him? Is it any concern of society's? First of all, to be sure, it is his way of making a living, but second, it is necessary to his employer's way of making a living, and finally it is necessary to society's way of making a living. In other words, the wage-earner's work is not actually a matter of his own free choice; however individually managed and controlled, however competitively bargained for, his work is a part of a great cooperative undertaking in which society as a whole shares and by which it profits.

If in many of the fundamental operations of this undertaking there is constant danger to life and limb, it is not just that those whose lot is cast in this part of the work should not only endure all the physical torture that comes with injury, but also almost the entire economic loss which inevitably follows. It is not just that the wives and children, mothers and fathers of those who do this part of the work, should not only bear the constant dread, the shock, the grief and sorrow and longing, but also pay in their own harder struggles and lesser opportunities, and narrowed lives, the money-cost of the tragedy. The physical suffering of the injured we cannot share. We cannot satisfy the longing or lessen the grief. But the economic loss we can share. Our failure to do this is an injustice to the wage-earner.

The Law as a Factor.

So far, except for an occasional mention, we have purposely left the much-discussed question of employer's-liability untouched. It is well to form the habit of considering the subject of industrial accidents without using that phrase. Speaking in terms of law the employer is "liable" for a very small proportion of the accidents which occur in his work. Referring to [the first of the two tables here reprinted] the employer would of course not be held liable for that 26% of accidents which were truly unavoidable, nor would he be held liable for that 27% of accidents attributable to those killed of their fellow workmen.[1] For the 15% for which there was divided responsibility he would not be held liable, because any contributory negligence on the part of the man injured bars his claim. This brings us down to the 29% "attributable solely to employers or those who represent them in positions of authority." For these we should expect to find the employer liable even under the common law. But he is not. In the first place "those who represent him in positions of authority" would most of them be considered fellow-workmen of the injured, and by the famous fellow-servant rule the employer would not be held liable for their negligence,[2] unless he had been careless in selecting or retaining them, which is seldom true and almost impossible to prove. In the second place, very often in a case where the employer would otherwise be liable, for instance where a long-standing defect has caused the accident, the employer can defeat recovery by showing that the injured employee knew of this defect and allowed himself to be employed in spite of it. This is according to the well-known "assumption-of-risk rule."

Out of 355 fatal accident cases, 17 suits are pending and 8 settlements of over $2,000 were made. Assuming that the plaintiff will win 9 of the 17 suits, we have out of 355 industrial accidents in which a family wage-earner was killed, 17 of which the law secured the right of compensation to the defendants. Those who settle are fortunate. If the case comes to trial, the litigation often lasts from three to five years. If damages are recovered, they amount, in case of the death of a married man, to about $5,000, 40% of which usually goes to the attorney. The law then secures restitution of about $3,000 to 6% of the widows and children of workingmen killed, and they may have to wait five years to get it.[3]

Turning to the other side of the situation, we find that the operation of this law, which is of so little advantage to the victims of industrial accidents, means a considerable expense to employers. The law, as we have seen, makes the employers liable for very few accidents, but the actual application of it is so uncertain and un-

[1] It is a gratification to the writer to learn that a study of the causes of accidents to workmen in Germany results in nearly the same proportion attributable to the workers—29%. K. Hartman's "German Working Men's Insurance." Part III., p. 7.

[1] "Households Builded Upon Steel," by Margaret F. Byington, in "Charities and The Commons," March 6, 1909.

[1] We are considering Pennsylvania law, which does not differ fundamentally from the laws in other states.

[2] A recent employer's liability statute in Pennsylvania will somewhat change this application of the fellow-servant rule.

[3] This is a more than liberal estimate of the plaintiff's chances. Decisions of the Supreme Court of Pennsylvania in cases of this kind in 1904 were 71% for the defendant.

equal—it depends so upon the cleverness of lawyers, the leanings of judges, and the temper of juries—that the employer must be prepared to fight a suit over nearly every accident. This constant necessity of being ready to fight and the always threatening possibility of having to pay heavy damages as the result of an accident, put the employer to the constant expense of maintaining a special claim department and the occasional expense of big attorney's fees.[1]

Moreover, while the liability law probably secures indemnity in only about 6% of the industrial accidents, it is nevertheless of fundamental importance in determining the system by which compensation is or is not made. If employees had no rights against their employers in case of accident, if it were the law that employees assume the risk of every accident possible in the course of their work, then whatever compensation was made would be prompted by a spirit of genuine benevolence and received in a spirit of genuine gratitude. The amounts paid would be much smaller, no doubt, and there would be even more families left totally without compensation, but in many respects such a situation would be an improvement on the present one. Whatever money was paid out by employers would go directly to meet the needs of the victims. There would be no elaborate and expensive claim departments to maintain on one side, and no heavy contingent fees to be paid on the other side. There would be no long delays and no litigation. What is more important, there would be no added strain upon the relation of employers and employees. To-day, very often, even in the making of small settlements, a bitter and grumbling demand inspired by a dimly-conceived right is met with an ungracious, small, and boastful benevolence.

Will the Problem Solve Itself?

We have set forth the fact that in over one-half of these deaths and injuries from industrial accidents the employer bears no share of the income loss resulting to the families concerned, and that in those cases where some compensation is made, it is, except in rare instances, an inconsiderable proportion of the loss. We have gone further and shown that much actual hardship and deprivation result from this injustice. Finally, we have tried to give some conception of the machinery by means of which all this mal-adjustment operates, showing that as a method it must be condemned because it accomplishes a minimum of good with a maximum of time, expense and bitter striving. Now let us consider what hopeful elements there are in the situation.

In the first place, among those employers of the Pittsburg district who deal with many accidents, there are at least two whose regular policy it is to make a small settlement in each case, even though there be no danger of suit. The employees injured receive a sum which bears some appreciable relation to the weeks of disability; if an employee is killed something is always paid to his dependents. The average paid to dependents of married men by these two employers in eleven cases was $550.

This first "hopeful feature," the voluntary generous policy of certain employers, indicates that the injustice of leaving the whole burden of accidents upon the workmen is beginning to be realized, and for this reason it is important. But we cannot depend upon this to bring about a just distribution of the loss. In the first place, where this policy prevails, it is not generous enough, especially in cases of death. We could not expect, by any legislative adjustment of this burden, that the employer should share each loss equally with the family of the employee killed. But, on the other hand, we must not be satisfied with $500 as the employer's share of a loss borne by the family which averages $14,271.[2] Moreover, as we have seen, this comparatively generous policy is far from general.

A second hopeful feature is that many employers have established relief associations to which they contribute as well as their workmen. In no two of these are the employers' methods of contributing exactly alike. Of the associations in which membership is actually voluntary and in which members are entitled to benefits without relieving the employer of his legal liability, the Westinghouse Machine Company Mutual Aid Society, organized in 1887, is one of the best. Every member pays 50 cts. a month dues, and is entitled to $7.50 a week for six months in case of injury,—$5 from the fund and $2.50 from the company. In case of death, funeral expenses only are provided for ($150), $50 being contributed by the company. In other words, the employer contributes one-third of the benefit.

A consideration of these two hopeful features of the situation brings us to the conclusion that they are hopeful, chiefly because in each of them lies the recognition of a certain principle,—the principle that an industrial enterprise should share the economic loss resulting from accidents to its employees in the course of their work. We do not belittle the significance of this recognition. But we have no reason to believe that it will soon become general. (This is of course the inevitable objection to leaving a matter which means injustice and serious deprivation in thousands of families to solve itself by the voluntary action of individuals.) Moreover, where such recognition does exist it does not lead the employer to assume a large enough share of the loss to remedy its unjust distribution. The bulk of the burden still falls upon the injured workman and his family.

So long as the assumption of a share of the burden remains voluntary, it is bound to be a small share; for no matter how generous an employer may be, the stress of competition will prevent his voluntarily assuming a large cost which his competitor does not assume.

Although we are thus forced to conclude that the solution of this problem does not lie along voluntary lines, we may well embody the principle thus voluntarily recognized by the best employers, in some law which will abandon the "liability" principle, and make compensation uniform for all those injured or killed in the course of work. Thus we should put all employers on an equal footing; we should get rid of the long and costly struggle involved in the operation of the present employer's liability law; and far more important than these, we should accomplish a just distribution of the economic loss involved in industrial accidents. Such a law, by making compensation for accidents a regular cost of the industry, against which employers could insure at moderate rates, would result in shifting a share of the economic loss of each accident from the family immediately affected to the whole body of consumers.

A Possible Solution of the Problem.

How then can we get rid of the "liability" principle? Certainly not by tinkering with the present Employers' Liability laws. The only way to get rid of a wrong principle is to adopt the right one in its place. Recognizing accidents to the workers as, to a large extent, a regular and inevitable attendant of modern production, we must abandon the principle of our present laws, i. e., that the workman assumes the risk of all accidents in the course of his work except those due solely to the legal "negligence" of his employer. We must adopt in its place the principle that an employer insures his workmen in a limited amount, against loss from all accidents in the course of work, except those due solely to the conscious wilful fault of those injured. Thus apparently we should at the same time extend and limit the employer's "liability,"—extend it to cover almost all industrial accidents, and limit it to a certain fixed and moderate proportion of the economic loss resulting from each injury. In reality, however, we should forsake the "liability" principle entirely. For "liability" suggests and intends and almost always produces "litigation," whereas the new principle in reasonably successful operation, calls for little more litigation than there is to-day over the payment of wages. An employer would be "liable" for compensation to all his workmen injured just as he is "liable" for wages to all his workmen. There would be disputes between the parties; of course—disputes over the length of disability in case of injury; in rare cases disputes over whether the accident was due "to the conscious wilful fault" of the injured man. These questions could be settled by some simple form of arbitration, for which the law would provide, and at the cost of the state. There would be no disputes calling for long expensive law suits.

Fortunately, perhaps, we are the last of civilized countries to hold on to the old liability law with regard to industrial accidents. Germany first, in 1884, then Austria, Finland, England, France, Italy, Holland, Sweden, Denmark, Belgium and Hungary, in order, have passed laws which embody the principle that an industrial enterprise should regularly share the economic loss resulting to the workmen injured by its accidents. I say "fortunately" because, while it is some disgrace to us to be so far behind, it is a distinct advantage to have the laws of other countries in actual operation before us. The laboratory work has been done and we can profit by the results.

Workmen's Compensation in England.

Let us look at the experience of England. The "employers' liability" situation there in 1893 was just about what we have in the United States to-day. After various unsuccessful attempts to increase liability by attacking the "fellow-servant" and "assumption-of-risk" defences the English Workmen's Compensation Act was passed in 1897.

This act was limited in its application to employees on railways, in factories, mines, quarries, in engineering work and in construction work on buildings above 30 ft. In 1900 agricultural workers were included, and by the act of 1906 practically all employees were included, even domestic servants.

The main provisions of the English law as it now stands are these:

(1) Employers are required to compensate those injured in their employ and the dependents of those killed according to the following fixed rates:

Fatal Cases: Three years' earnings to dependents, if there be any. If not, medical and funeral expenses, not to exceed ten pounds ($48.67).

Non-fatal Cases: A weekly payment not to exceed 50% of average weekly earnings, fixed according to degree of disability. This payment continues so long as disability lasts.[1] (Employers insure against this required compensation at rates no higher than are paid in this country for Employers' Liability Insurance.)

(2) If it is proved that injury was due to "serious and wilful misconduct of workmen injured," compensation is not allowed, *except when injury results in death or serious and permanent disablement.* (Disputes over this exception have proved few.)

(3) An employee injured may claim compensation under this act or sue for damages under previous laws, as he chooses, but he may not do both. If, however, he fails in a suit, he may have his compensation awarded under this act, with the costs of his unsuccessful suit subtracted. (There is less and less recourse to the damage suit as time goes on.)

(4) In case of the bankruptcy of an employer, if he is insured against the liability in this act, the rights of the employer against the insurance company are transferred to the injured workman.

(5) An employer may organize a scheme of accident insurance which shall exempt him from the provisions of this act, provided he secures a certificate from the Registrar of Friendly Societies that the provisions of his scheme are not less favorable to the workman than the provisions of this act, and that a majority of the workmen are in favor of the scheme. No scheme can be certified which makes joining a condition of employment, and every scheme in order to be certified must have provisions enabling a workman to withdraw. Complaint can always be made to the Registrar by workmen included in such a scheme.

(6) Disputes arising under the act, if not settled by agreement, are settled by arbitration. The judge of the county court acts as arbitrator, or a single arbitrator appointed by him may act. An appeal on questions of law may be taken from this decision to the court of appeal and from there in English cases to the House of Lords. (The vast majority of cases are settled by agreement between parties.)

This law has been in operation twelve years; it is no longer an experiment. It has accomplished its chief purpose by securing compensation to the injured workman and his dependents; its method of operation has proved comparatively simple and inexpensive; it has not proved a ruinous burden to employers, because it results in a definite and reckonable cost against which they can insure at reasonable rates. Minor changes will be made from time to time as experience proves their necessity, but in its main provisions the law has justified itself. It deserves our careful consideration.

Those who wish to pursue further the general subject of workmen's compensation may find two articles in the March Bulletin of the New York Department of Labor (John Williams, Commissioner, Albany, N. Y.). The first of these articles is by Mr. P. T. Sherman, recently Commissioner of Labor for New York State. It is entitled "The Constitutionality of a Workmen's Compensation for Accidents Law." We quote the introductory paragraphs of Mr. Sherman's article, as follows:

Practically all industrial states, outside of the United States, have abandoned the principles of our law relative to the liability of employers to employees in hazardous and organized industries, and have substituted therefor laws based upon principles radically different from ours but essentially identical among themselves. The cardinal principles of our law on this subject—which is a branch of the law of negligence—are that an employee assumes the ordinary risks of his employment, but that the employer is liable to him in damages for injuries due to the negligence of the employer (or of a superior fellow servant) to which the negligence of the employee has not contributed. The principle of the foreign laws—which may be termed the rule or law of "compensation"—is that the proprietor of an organized or hazardous industry is liable to his employees, in certain amounts fixed by statute, depending upon the nature of the injury, for compensation for all injuries occurring in the course of employment, unless due to the serious and wilful misconduct of the victim. (This last exception varies in its terms in the different laws; and in some is omitted altogether.) In some countries the law requires the employer to take out insurance to secure to his employees the payment of the compensation. This is known as "compulsory insurance." But from a legal point of view it is simply a further obligation added to the liability for "compensation." The law of negligence with us is administered by courts in ordinary procedure; and the amount of damages, if not agreed upon by settlement, is fixed by juries. The details and administration of the compensation laws vary in the different countries; frequently they are administered by ministerial officers instead of by courts; and quite generally

[1] Those who avoid this by taking out employer's liability insurance save themselves annoyance. But the premiums are so high that it means little or no decrease in expense.

[2] This is an average for 193 cases reached by multiplying yearly income by expectation of life and subtracting $300 a year to cover maintenance of man killed.

[1] Details and exceptions omitted.

the facts upon which the rate of compensation depend are determined by arbitration or state medical officers instead of by judges and juries.

It is not intended here to explain or discuss the respective merits and demerits of the two systems. The reader who wishes to inquire into that question is referred to other sources.* It is sufficient for the purposes of this article to express an opinion, supported by the authorities, that the foreign system is incomparably the superior, and that our adherence to our law of negligence is due to ignorance, inertia and a prevalent belief that the provisions of our constitutions oppose a practically insurmountable obstacle to the adoption of a compensation law.

It is the purpose of this article to show that the provisions of our constitutions do not constitute such an obstacle.

In the state of New York we are governed by the constitutions of the state and of the United States. Sections 2 and 16 of Article I of the state constitution probably do stand in the way of the adoption of a practicable compensation law. But the state constitution can be easily and speedily amended when public opinion demands it. Therefore these provisions can be repealed or modified and a compensation law specifically authorized whenever public opinion so demands.

There remains only the Constitution of the United States. By its terms it may be amended; but the procedure is so difficult that, for the purpose of this discussion, it may be treated as practically unamendable. But there is nothing in that constitution to prevent the state of New York from substituting the essential features of the foreign compensation laws in place of its law of negligence, so far as it relates to the liability of employers in organized and hazardous industries. It is not meant that we can adopt the particular compensation law of any foreign country in its entirety (with the possible exception of the English Act of 1897), without violating some of the provisions of the Federal Constitution. But we can frame a system of our own, based upon the fundamental principles of the foreign laws, without so doing.

Most of the remainder of the article consists of citations of court decisions bearing on the subject under discussion.

The second article in the bulletin named is entitled "What a Republic May Do for Its Workingmen Through Accident Insurance." This study is by Dr. Lee K. Frankel, and presents the results of investigation made in Europe by the author under commission of the Russell Sage Foundation.

Dr. Frankel opens his remarks by showing the close resemblance between the form of government and the character of the people of Switzerland and the United States. In contrast to the United States, however, Switzerland shows a marked difference in its social legislation for the protection of workmen against industrial accidents. In the United States the old common-law doctrine still maintains, but Switzerland was one of the first countries in Europe to set aside this doctrine for one which more clearly implied the idea of compensation. As early as 1875 a Federal law imposed upon railroad and steamship companies the responsibility for accidents to employees, even if the accident was not due to the fault of the employer.

The same fundamental thought was provisionally expressed in the law of March 23, 1877, regarding work in factories, and was confirmed by the law of June 25, 1881. The law of April 26, 1887, extended the previous law to cover other industries, particularly building, transportation, technical installation, railway, street and bridge operations, quarries, etc. The law of April 5, 1884, extended the principle to the postal service, and the one of June 24, 1902, to certain particular industries involving electrical installation. The law of 1875 has been replaced by the law of March 28, 1905, which is practically the earlier law with a few unimportant changes.

The author next takes up in considerable detail the legislation, actual and proposed, for accident insurance for workmen. Lack of space compels us to refer those interested to the bulletin named above, for further details.

*To the general reader interested to pursue the question of "compensation" versus "liability, based on negligence," the following references to a few articles in English are suggested. Further references to the literature of the subject may be found in the first three of these:

Willoughby, W. F. Workingmen's Insurance, N. Y. (Crowell), 1898.

Henderson, C. R. Industrial Insurance in the United States. Chicago. (Univ. of Chicago Press), 1909. Ch. V.—The Employers' Liability Law.

Adams, T. S., and Sumner, H. L. Labor Problems. N. Y. (Macmillan), 1905. Pp. 478-493.

New York State Department of Labor. Employers' Liability and Accident Insurance Laws, Bulletin No. 34 (September, 1907), p. 357. Employers' Liability or Workmen's Compensation, Bulletin No. 39 (December, 1908), p. 442.

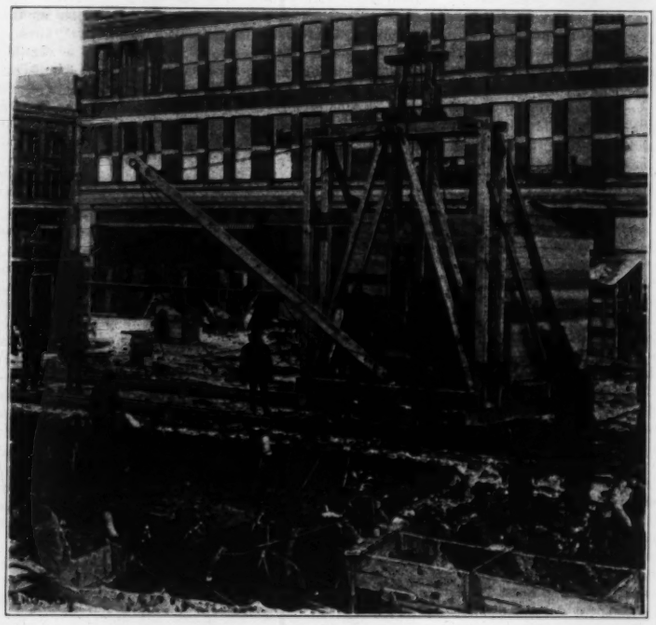
Wisconsin Bureau of Labor and Industrial Statistics. Thirteenth Biennial Report, Part I, Industrial Accidents and Employers' Liability in Wisconsin.

Packer, Launcelot. British Workmen's Compensation Acts, Bulletin of the United States Bureau of Labor, No. 70, (May, 1907), p. 639.

Eastman, Crystal. One Year's Work Accidents and Their Costs (Report of the Pittsburg Survey), Charities, March 6, 1909, p. 1143.

A Machine for Excavating Trenches and Foundations in Frozen Ground.

The excavation of trenches and foundations in winter is a troublesome task in northern cities, where the frost penetrates to a great depth and the ground may remain frozen from November to April. A machine for excavating frozen ground has been recently introduced in Winnipeg (Canada), and during the past winter it has proved a success on sewer trenching and foundation work. The contractors who have used it are said to be well pleased with its work. One important feature in excavating during the winter months is that no shoring or timbering of the sides of the trench is required. This means a large saving in both material and labor.



A DROP-CHISEL MACHINE FOR EXCAVATING AND TRENCHING IN FROZEN GROUND

(Wm. Hurst, Winnipeg, Canada, Inventor.)

In that city the frost penetrates to a depth of 5 ft. to 6½ ft. Previous to the introduction of this machine all earth excavation during five or six months of the winter has been done by hand picking or by blasting the frozen earth with black powder. By hand picking, the cost of excavating frozen soil has been approximately $1.35 per cu. yd. By blasting with powder, the cost has been in some cases reduced to 93 cts. per cu. yd., but usually runs about $1.25 per cu. yd. The use of dynamite for blasting within the city limits is considered too dangerous.

The machine is in principle similar to a pile driver, or to the rock-breaking machines used in submarine excavation. A frame mounted on a platform carries a set of leads for a hammer or ram attached to the head of a chisel bar. The hammer is raised about 15 ft., and released, the force of the blow causing the chisel to penetrate the frozen earth and break it away in large blocks. The leads have a horizontal travel of 10 ft. in the supporting frame. Attached to the platform is a derrick boom for removing the large blocks broken off by the machine, these being loaded into wagons or cars for removal or placed at the side of the street in sewer trench work. The platform is mounted on wheels which travel on a track, and carries the engine and boiler used for operating the chisel bar and hammer.

The accompanying illustration shows the machine at work on the excavation for the foundations for the Enderton Building at the corner of Portage Ave. and Hargrave [illegible], Winnipeg. The machine travels along the [illegible] of the excavation, breaking down the face as it goes. For trench work, however, the machine spans the trench, and moves parallel with it, the chisel-bar traveling to and fro across the face of the work. The machines now in use have [illegible] frames, but designs are being made for [illegible] machines with steel frames. These will be of four sizes: (1) for small work, such as foundations for residences; (2) for sewer and other trench work; (3) for large cellar and foundation excavations; (4) for railway, quarry and brick-yard work. All but the trenching machines will be mounted on turntables.

The machine has been used by the City of Winnipeg for excavating sewer trenches and by different contractors for the foundations of large buildings, Mr. J. Girvon being the contractor for the Enderton Building above mentioned. It has been used also by Mr. Carr, of Portage-la-Prairie (Canada), contractor for the needle-dam in the Assiniboine River, to excavate through 5 ft. of frozen sand for sheet piling. On the above works the average cost of excavating the upper layer of from 5 ft. to 6 ft. of frozen soil has been from 11 cts. to 30 cts. per cu. yd. The daily output has been from 200 to 300 cu. yds. in foundations, and from 50 to 60 cu. yds. in sewer trenches. Mr. H. N. Ruttan, M. Am. Soc. C. E., City Engineer of Winnipeg, informs us that the machine does its work very effectively and very cheaply, the cost of excavating frozen ground being probably 33% that of hand work.

The machine is covered by American and Canadian patents. It is the invention of Mr. Wm. Hurst (a former superintendent of sewers), 180 Good St., Winnipeg, Man., Canada. To him we are indebted for photographs and other information.

THE NATIONAL EMPLOYER'S LIABILITY ACT OF 1908 has just been upheld as constitutional in a case decided by Judge Trieber in the Eastern District of Arkansas, namely the case of Watson, Administratrix v. St. Louis, Iron Mountain & San Francisco Ry. Co. This law just upheld was passed in place of the act of 1906, which was declared unconstitutional by the courts. The effect of the act is to make an interstate common carrier liable for injuries to an employee notwithstanding the accident causing the injuries may have been due to the neglect of a fellow-servant.

THE FREIGHT-CAR SITUATION shows but very slight symptoms of improvement. The total number of idle cars has been decreasing slightly since January, and a trifle more distinctly so since the beginning of April. The variations are somewhat erratic, however. The last reported figure, for May 26, is 273,890, a decrease of 10,589 in two weeks, or a decrease of 8,438 in four weeks, or a decrease of 22,710 in eight weeks. There is not a corresponding improvement in box-cars, which have shown a steady increase in idle cars since February. The present figure (May 26) is 118,257, which is an increase of 4,656 in two weeks, an increase of 10,592 in four weeks, or an increase of 16,913 in eight weeks. In 1908 the maximum of idle cars was reached at the end of April, and from then until November there was a rapid and steady decrease in the surplus, both for box-cars alone and for all cars. The season of 1909 seems to be over a month later in regard to the summer increase in railway business.

An Example of Defective Truss Construction.

By C. A. P. TURNER,* M. Am. Soc. C. E.

To an engineer having varied practice in structural work the common idea that any one type—timber, steel, brick or reinforced concrete—is especially free from liability to blunders in design or execution is a source of no little amusement. Thus our brick and burned clay advocates, assisted to some extent by structural steel interests, magnify the dangers of concrete construction, while steel, timber and brick receive little comment as they are older in the field. The writer has frequently been called upon to strengthen timber and steel-frame buildings improperly designed, as well as to remedy defects in the design of concrete construction which became apparent during erection. On the other hand he has never been called upon in connection with a reinforced-concrete structure after the same had been finished to a sufficient extent to use. The reason for this is not because designs in concrete are not as frequently defective as in steel and timber, but rather because the gradual increase in strength of concrete material with age tends to make good the errors or blunders in the general design or the construction.†

These statements are illustrated by a recent experience in investigating the failure of a steel truss, and by some earlier experiences of failures of timber or brick structures. The examples also serve to support the writer's opinion that the majority of failures in structural work of all kinds is chargeable to ignorance or oversight on the part of the designer, rather than to defective execution of work. Ignorance does not always consist in lack of familiarity with engineering literature, but often in careless omission to analyze the conditions which determine the applicability of theory to a particular case.

A few years ago the writer was called upon to report on a failure of a concrete and steel roof in a state building. Two engineers had previously reported on the collapse (for the contractor), one of the gentlemen stating he was or had been connected with the designing department of one of our largest bridge companies and was an Associate Member of the American Society of Civil Engineers. The roof frame consisted of an ordinary Fink truss with concrete roof and ceiling. The engineers figured by a formula for eccentric stress taken from "Modern Framed Structures," incorrectly applied and concluded that the angle posts failed under the working load.

Test of full-sized members with identical end connections developed *four times the strength they had figured* sufficient to cause failure. Investigation of the building disclosed that the truss seats at one end rested on an offset wall formed by a slightly projecting bay window. This had been built up, contrary to specifications,

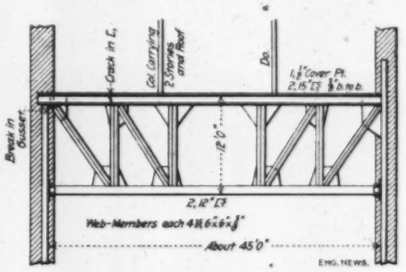


Fig. 1. Sketch Elevation of Truss Carrying Four Floors and Roof.

with soft brick and hollow tile blocks, which merely cracked through and sheared out at the corners, dropping the trusses.

An amusing feature of this failure of hollow tile and brick was that it was promptly advertised by burned clay interests as an example of the dangers of concrete construction. The writer's recommendation covered only the proper reconstruction of the walls.

In timber buildings, the writer has seen an 8 × 16-in. timber, cut square, butted against a column and supported by a cleat of 2 × 8-in. stuff 10 ins. long, spiked against the post. In designing stirrups the mistake is not rare of taking the net section in tension without taking into consideration the bending due to bending the hanger over the support. Both these errors may be classed as careless oversight.

The most recent and most interesting example of a dangerously defective structural steel frame that the writer has been called upon to strengthen is illustrated herewith.

A room having a clear width of between 40 and 45 ft. was spanned by a Pratt truss of five panels, 12 ft. deep, which carried four floors and a roof above. The top chord of this truss consisted of two 15-in. channels, ⅝-in. back to back, with a ½-in. coverplate; the bottom chord of two 12-in. channels; the posts and diagonals each of four angles 6 × 6 × ⅝-in. Columns resting on the top chords at the third-points carried the upper floors (Fig. 1).

Gradual sagging of the floors over this room, with accompanying cracks, was attributed to defective concrete. Uncovering the connections between the end of the first truss and the column showed the condition exhibited by the photograph Fig. 2. Here it was found that the end diagonal, composed of four angles 6 × 6 × ⅝-in., was attached to a 22 × ⅝-in. plate, at one edge of that plate, and that the eccentric stress had been gradually tearing the plate apart during nearly four years. Trusses 2 and 3 were found in a similar condition; Fig. 3 shows the torn plate of Truss 2. Evidently as soon as the gusset gave way, reducing the stress in the diagonal, the load was carried by the top and bottom chords cantilevering over a full panel from the last vertical of the web-system, assisted somewhat by the plaster partitions and concrete floors above.

The severe strain on the chords due to this condition was shown by a clean break in one of the 15-in. top-chord channels, as illustrated in Fig. 4. The concrete in the floors was an exceptionally inferior grade of cinder concrete and yet the writer found the truss still standing under a load sufficient to first fracture the gusset holding the main tie and then break one of the main channels acting as a cantilever beam. Posts were promptly placed under these trusses and repairs proceeded with. Fig. 5 shows the connection used for repair, with counter-brace not yet added.

At the other end of these trusses the ⅝-in. plate was connected to the column as well as the chord, but at the end which failed the projecting ends of the top chord rested on the column and the main diagonal was connected to a 22 × ⅝-in. plate riveted between the top chord alone. Evidently this gave a section equivalent to 48 × ⅝-in. pulling on a section of 22 × ⅝-in., and on one side of that. (See Fig. 1.)

The general design of this truss was liberal in the sections of the main members; in fact, there seemed to be 15 or 20% more material than requisite for safe construction, while in detailing no attention had been given to the relative proportion of the main tie and the gusset and no thought given to the question of pulling centrally on the insignificant section used. Undoubtedly the draftsman responsible for these details carefully figured the exact number of bolts required in shear on a given basis, but the idea of investigating his work to see that in general the various parts were roughly of proportional strength had not occurred to him.

In almost all engineering work the rough method checking by proportion is the greatest safeguard against numerical errors that can be employed. Mistakes are commonly made in figuring by the most reliable men in the profes-

Fig. 2. Truss 1.

Fig. 3. Truss 2.

FIGS. 2 AND 3. TORN GUSSETS AT END OF TOP CHORD, TRUSSES 1 AND 2.

*Consulting Engineer, Phoenix Bldg., Minneapolis, Minn.

†But an instance of the contrary was recorded by H. A. D. Saurbrey in our issue of Nov. 5, 1908, p. 488, which the reader should consult.—Ed.

sion, but these men as a rule have some system of checking by proportion or rough comparison in the line of work that they are constantly doing. Investigating estimates or designs in this manner takes but little time, and errors of magnitude are generally caught up almost as certainly as by the more thorough system of checking which is too often inadmissible in the hurry and rush of the estimating department of a large manufacturing and contracting company.

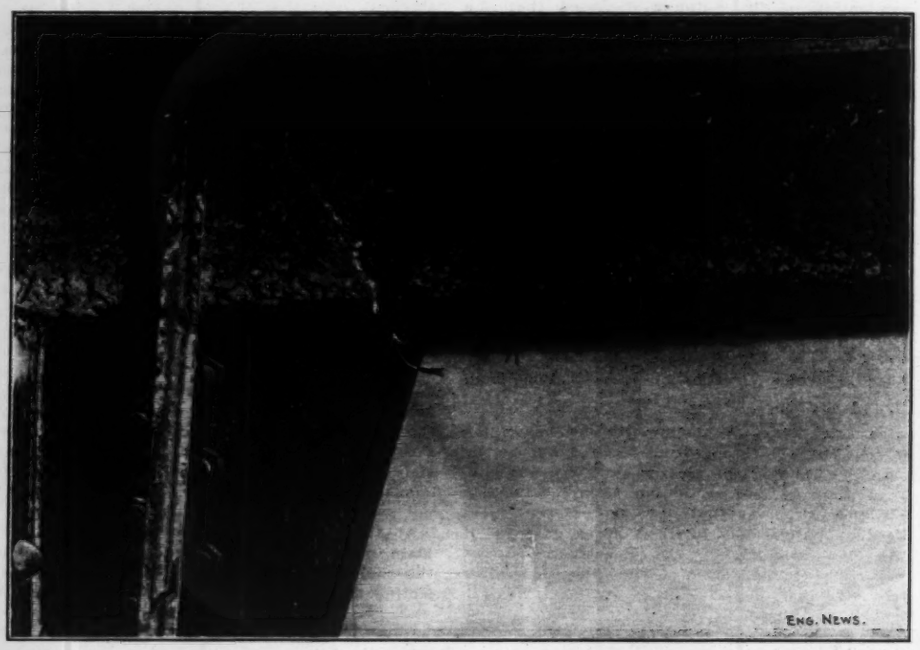


FIG. 4. TOP CHORD BROKEN ACROSS, ONE PANEL FROM END, AFTER FAILURE OF END GUSSETS.

Some Advice to Young Engineers About to Go to the Tropics.*

By JOSEPH A. SARGENT,† Assoc. M. Am. Soc. C. E.

If an elder brother may presume to offer a few words of counsel to the younger brothers of the profession, though he knows unsolicited advice is usually of questionable value, I would invite you to note that the islands of the Carribean Sea, the Republic of Mexico and all of South America are now one vast theater of progressive constructive enterprise. The day of the finding of hidden pirate treasure has long since gone by, except in romantic novels, and the day of the financial adventurer and soldier of fortune is rapidly waning. The countries of the eternal *manana* are stirring in their dreams. It is being whispered that a great canal is being cut between two continents that will bring into the world a new era. These are, in truth, lands "where every prospect pleases and only man is vile." In the next fifty years these countries will make greater strides than will our own, for they are pitifully far behind in mechanical and scientific fruits of civilization, though in some of the "*humanidades y urbanidades*," we are a century behind the Spanish in precept and in act.

There is and will continue to be a crying need for trained men in the tropic countries. The men who answer the call of "*Men* Wanted" (and you can rest assured that some few of the younger brood will want to try their wings) must go prepared to accomplish twentieth century tasks, often with the aid of sixteenth century men, who have suddenly found themselves confronted with our ruthless law of the survival of the fittest. The dictators of thought in the Latin-American countries are teaching the rising generation that they must climb or perish, and the leaven is taking hold. Some of them are beginning to work as their forebears, since the days of the strenuous Cortez, never worked.

These people must have the help of men trained to the hour, who are strong in working power, of unquestioned moral courage and integrity, who are sensible and unselfish. The man blessed with these qualities, who holds no necessary working task and no humble worker in supercilious disdain, may hope to succeed where the many fail. In these lands now opening to our peculiar civilization the need of such men is legion, and reward will be in proportion to the goods delivered.

The good workman dare not despise his tools, be they peon laborers, 90-ton steam shovels, or the language and the understanding of the people where he must earn his bread. The young engineer who comes to the tropics must learn how to live a rigidly cleanly, sanitary and upright life in the midst of wretched poverty and squalor, if he is assigned to duties in the interior. Some of the cities can give our northern civilization pointers in sanitation, but the rural districts are still in the Dark Ages.

If you go into tropic service, all the practical points you can get on camp sanitation, proper cooking of plain foods, meats and vegetables by broiling, roasting and baking, are information that is golden. From observations made in Mexico and in Cuba, it has been my experience that a normally healthy man who does not eat grease and garlic, who leaves strong drink alone, and who never backslides in the maintaining of sanitary camps, seldom loses his health beyond light acclimation fevers, unless he is distraught from overwork and permits himself to worry.

Unfortunately many of our northern young men when they leave home behind seem to think they are in duty bound to measure their capacity to drink the famous rum made by Mr. Bacardi, who probably has more serenades sung in his honor than any other man in the sub-tropics; but the sensible man is he who cuts it out.

As to the Spanish language. It is a pity to see, as I have frequently seen, one of the best products of the North American university from say, any school between bluenose land and the Golden Gate, sent into the interior and turned loose to handle his first responsible job. If he does not know his Spanish and has no interpreter (and the average interpreter is usually too vague for precise and urgent work) a painful tableau ensues, to be continued for from three to six months, depending upon the man's facility in learning bastard Spanish. Confused native foremen and *capatazes* more or less anxious to please and to a limited degree fists of the *Jefecito Nuevo* and all need of intelligible instructions, sta shoulders, making apologetic gestur grinning open ridicule. The perspir finds himself in the class of the deaf without knowing the dumb alphabet.

In trying to explain his orders he w legs, jumps up and down in the air, u his vocabulary of stock and original p pictures in the dirt with a stick, and fair imitation of a Crow Indian mak usually comes to the conclusion tha country, in which the people are all f his suffering subordinates hold somew ings, but contrary opinions to the *todos de los Americanos son locos.*" formance causes the hapless and hel search his soul for picturesque swea cause his Spanish is limited to "*Bu leros*," "*Gracias, Senor*," and "*Adios* are too mild to suit the needs of the m

The writer would not for one mo cutting of your French or your Deuts ever, the idioms of diplomacy and ph would urge you to make any sacrifice learn the language of the countries conduct the heaviest percentage of our

Paraphrasing a current humorist, I be said in truth that for the engineer of value, if only considered from the selfish standpoint of mere usefulness.

When you are called to a construction job in the tropics, every word of useful Spanish at your command will be a balm of joy to your overworked colleagues, for you can thereby share their tasks.

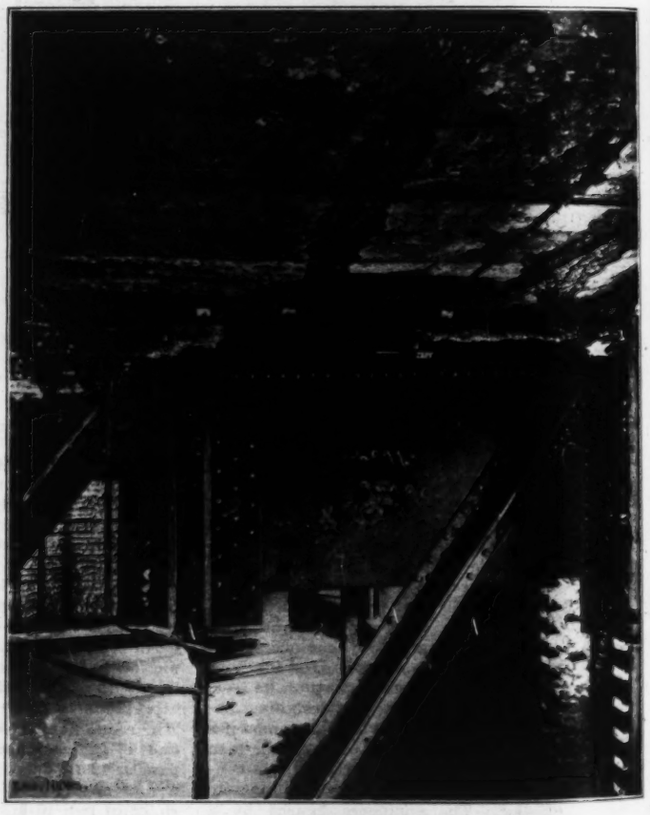


FIG. 5. REPAIR OF END PANEL OF TRUSS.

THE AVERAGE DAILY VOLUME OF SEWAGE handled by the main sewerage system of the London (England) County Council in 1908 was 330,000,000 U. S. gals. During times of storm the volume of sewage is likely to be increased to 1,200,000,000 U. S. gals. per day. From 900 to 1,000 men were employed on the main sewerage system during 1908. The "net capital expenditure" on the system up to March 31, 1909, was £11,110,389, or in round numbers over $50,000,000. There are two main outfalls, one on each side of the Thames, each having a discharging capacity "under the present conditions" of about 600,000,000 U. S. gals. per day. The foregoing information has been taken from the descriptive account of the "Main Drainage of London," by Maurice Fitzmaurice, M. Inst. C. E., Chief Engineer of the London County Council, which has just been published.

*From a paper in "The Nebraska Blue-Print," a publication of the Engineering Society of the University of Nebraska.

†Chief Engineer, Public Works, Manzanillo, Cuba.

A Novel Street-Railway Car.

By P. W. PRICE,* Assoc. M. Am. Soc. C. E.

A new development of the prepayment type of street car is now being tried in Pittsburg where it is known as "the corridor car." The only car of this new type, thus far built, has been running on the lines of the Pittsburg Railways Co. since April 8. It seems to have some advantages over any form of street car yet tried. Platforms have been entirely eliminated and a narrow corridor running along one side for about one-third the length of the car takes the place of the rear platform. The entrance is at the rear end of this corridor and the exit is near the center of the car. The conductor stands between the end of the corridor and the exit door, in a position to collect fares as the passengers pass from the corridor into the body of the car. He controls the exit door by a pneumatic device and may also similarly operate the entrance door if desired. Thus the conductor, from his central position, is enabled to completely control entrance to and egress from his car. Passengers getting off the car are directly under his eye while those getting on can be readily seen by glancing down the corridor, or, if this view is obstructed by those already occupying the passageway, the conductor can see when to start his car by looking out toward the rear through a window at his side especially arranged to slide back and forth easily.

It will be seen that, by this arrangement, incoming and outgoing passengers do not in any way interfere with each other, and that the motorman is relieved from the responsibility of overseeing the alighting of passengers at the front of the car as is expected of him, in the prepayment cars now in general use. This corridor arrangement also makes easy the introduction of any one of several automatic fare-registering devices.

The car now in use is divided into two parts by a partition carried across the car from the inner end of the corridor. The room at the rear end of the car, which in Pittsburg is used as a smoking room, in Southern cities might be used as a compartment for colored passengers.

It will be seen that this car has some important structural advantages over the ordinary enclosed cars now in use. Construction is simplified by running unbroken floor beams from end to end, with the exception of a cut in one outside beam to provide for steps at center exit. At this point the 1 × 6-in. steel reinforcing plate (which is bolted to the 4 × 6-in. outside floor beams for their entire length on both sides of the car) is bent around the steps in a U shape and is strongly bolted to the adjoining inside floor beam. The absence of special platform-floor sills attached underneath the main framing is a decided advantage, as this is a weak point in present construction. Platforms have a tendency to sag, which causes drooping fenders and is generally undesirable. This simple framing is claimed to effect a decided saving in cost as well as to provide a stiffer and stronger car. It also reduces dead weight about 15% compared with present cars of the same length. This is important, when it is considered that the cost of supplying electric power to cars in American cities ranges from $60 to $100 per ton per annum.

The car now in service, which is 43 ft. 1 in. long over end sills, has a seating capacity of 50. This is ten more than can be seated in a platform car of equal length and with similar longitudinal seating. The standing room is about the same as in other cars, with the advantage that all passengers are inside the car. The motorman and conductor are both stationed inside the car body, which is a benefit to them in stormy or cold weather. The Pittsburg Railways Co. is still trying the car and has not made any decision as to the merits claimed for it. So far it has attracted a great deal of favorable attention and seems to be meeting successfully the operating conditions of one of the hardest service lines in Pittsburg. The car was built by the Niles Car & Manufacturing Co., at Niles, Ohio, from plans furnished by Mr. Charles B. Price, Room No. 211, Frick Bldg., Pittsburg, who was for many years an official of the Allegheny Valley Ry.

*Oakmont, Pa.

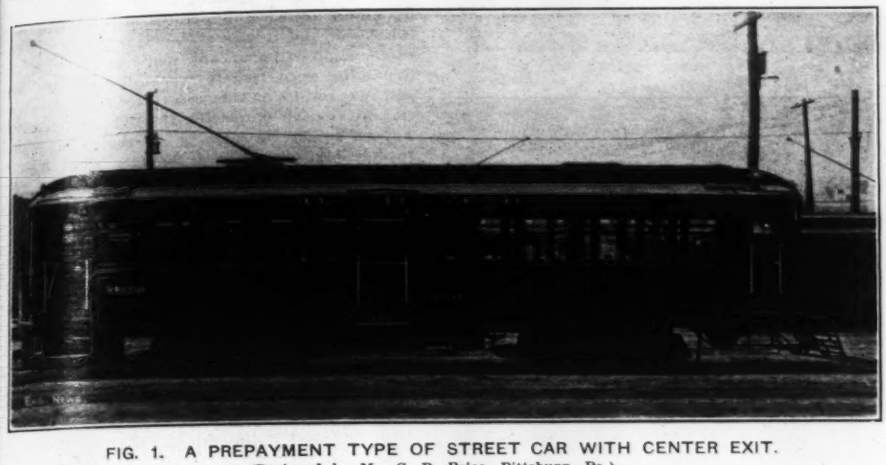


FIG. 1. A PREPAYMENT TYPE OF STREET CAR WITH CENTER EXIT.
(Designed by Mr. C. B. Price, Pittsburg, Pa.)

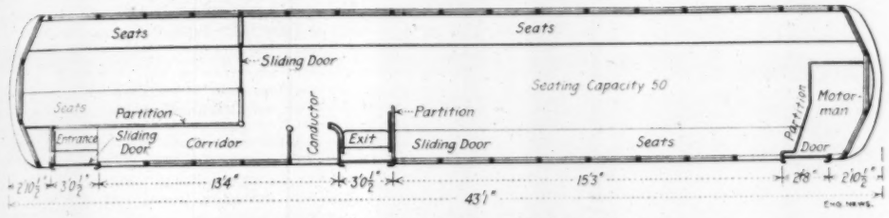


FIG. 2. PLAN OF PITTSBURG CENTER-EXIT CAR.

A GIFT OF $50,000 for the study of municipal government at Harvard University has been made by Frank Graham Thompson, of Philadelphia, a member of the class of 1897. The money is to be available at the rate of $5,000 a year, and is to be used through the Department of History and Government of the university. Inquiries made by the National Municipal League indicate that at least 40 American institutions are now giving independent instruction in municipal government, while many others are giving more or less instruction in connection with the general course in political science.

RAILWAY ACCIDENTS IN GREAT BRITAIN.—The most striking feature of the Board of Trade report respecting accidents and casualties which occurred upon the railways in the United Kingdom during the three months ended last December, is the statement that out of 317 persons who were killed no fewer than 156 were trespassers. The great bulk of these undoubtedly were cases of suicide. The total number killed shows an increase of one, compared with the corresponding quarter of 1907. The number of persons injured during the three months—2,049—shows a substantial reduction of 502. It is gratifying to note, states the report, that no passengers were killed and only 45 injured by accidents to trains during the quarter, compared with 14 killed and 204 injured during the corresponding quarter of the previous year. The number of animals was somewhat smaller than usual, nine horses, two donkeys, 23 beasts and cows, 21 sheep, nine pigs, and 11 dogs being run over and killed, and one cow injured during the three months.—London "Engineer."

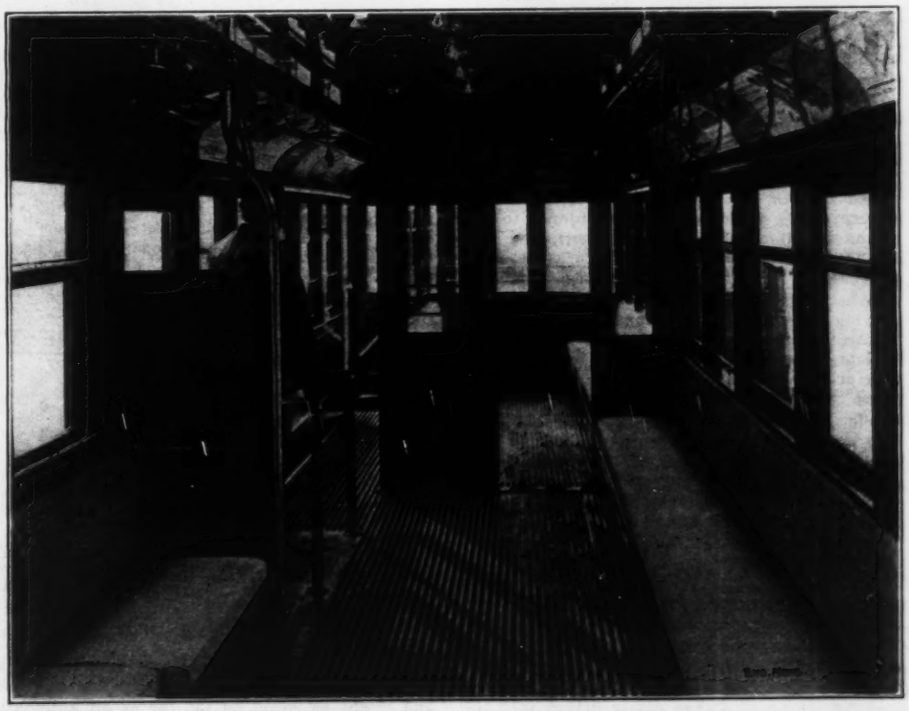


FIG. 3. INTERIOR OF PITTSBURG CENTER-EXIT CAR, LOOKING TOWARD THE REAR.

Fire-Resisting Construction at the New Temporary Crib for the 73d St. Water Tunnel at Chicago.

The disastrous destruction by fire of the superstructure of a temporary crib at a shaft in the lake at Chicago was described in our issues of Feb. 25 and March 11, and the structure is to be rebuilt on the lines of slow-burning or fire-resisting construction. This crib is at the head of an intermediate shaft in the new 73d St. water supply tunnel, and is a heavy timber structure, hexagonal in plan. The coroner's jury included three engineers (A. Bement, John M. Ewen and Benezette Williams), and the city authorities required that in the reconstruction of the superstructure the contractor must conform to the recommendations of the jury's report, and that the plans must be approved by a commission composed of the members of the jury. The style of construction adopted is shown in the accompanying cuts, and for drawings and information concerning this work we are indebted to Mr. A. Bement, Consulting Engineer, one of the members of the jury and of the commission. The plans were prepared by the Department of Public Works.

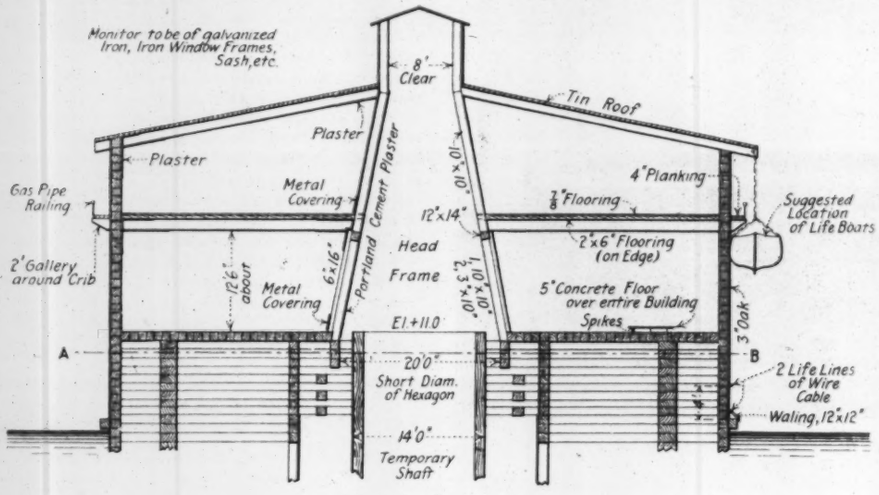


FIG. 1. CRIB SUPERSTRUCTURE OF FIRE-RESISTING CONSTRUCTION AT THE INTERMEDIATE SHAFT OF THE 73D ST. WATER TUNNEL, CHICAGO.

As noted above, the new structure will be built of timber, but on the lines of fire-resisting construction. Reinforced-concrete construction was proposed, and the contractor expressed his willingness to adopt this if required, but the commission considered that this would not be necessary or desirable.

The structure will be hexagonal, with sides composed of horizontal timbers 12 × 12 ins., and an exterior sheathing of vertical 3-in. oak plank. The main floor has a solid deck of 12-in. timbers, and this will be covered with a 5-in. concrete floor (4-in. base and 1-in. wearing surface) anchored by means of spikes partly driven into the deck timbers. In the center of the building will be a hexagonal head frame, covering the shaft, and this will terminate in a monitor which extends above the roof. The general construction and arrangement are shown in Fig. 1.

The second floor will have 18 radial stringers 16 × 18 ins., resting on 12 × 14-in. timbers in the head frame and on 12 × 12-in. sills in the outer walls. The stringers extend beyond the building and carry a 2-ft. walk or gallery, made of 4-in. planks and having a gas-pipe railing. Upon the stringers will be a solid deck of 2 × 6-in. planks on edge, covered with ⅞-in. flooring. The roof will have 18 stringers 12 × 16 ins., on which will be a solid covering of 2 × 4-in. planks, on edge; the planks are to be toe-nailed and well spiked to adjacent timbers, as in the second floor. A tin roof will be laid upon this solid timber roof covering. Where the floor and roof stringers rest upon the interior and exterior sills, the spaces between these sills will be filled solid with blocking, as shown in the detail, Fig. 2.

For fire protection there will be an equipment of pumps, hose and fire extinguishers. The commission considered the use of an automatic sprinkler system, but decided that it would be of doubtful value under the circumstances. It would involve difficulties in installation and use, and might be relied on too far as an automatic protection against fire. For means of escape, there are to be at least three lifeboats, suspended from supports at the sides of the structure. An iron ladder will be provided at each corner, leading from the gallery to the water, and around the crib will be hung two life lines of wire cable, with attachments 7 ft. apart.

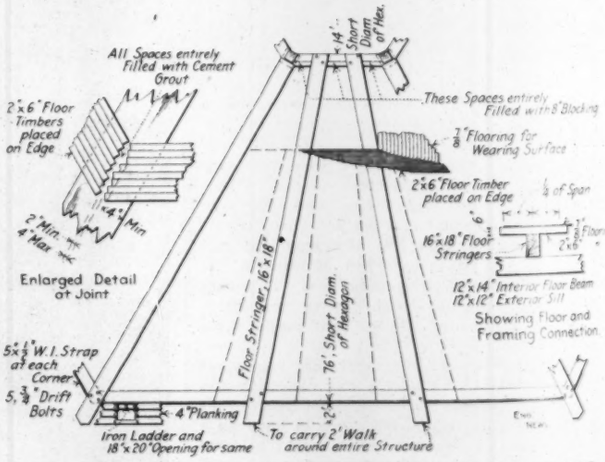

All Spaces entirely Filled with Cement Grout
2"x6" Floor Timbers placed on Edge
2" Min. 4 Max.
4" Min.
Enlarged Detail at Joint
14' Short Diam. of Hex.
These Spaces entirely Filled with 8" Blocking
7/8" Flooring for Wearing Surface
2"x6" Floor Timber placed on Edge
1/2 of Span
16"x18" Floor Stringers
12"x14" Interior Floor Beam
12"x12" Exterior Sill
Showing Floor and Framing Connection
5"x1/2" W.I. Strap at each Corner
5, 3/4" Drift Bolts
Floor Stringer, 16"x18"
76' Short Diam. of Hexagon
4"Planking
Iron Ladder and 18"x20" Opening for same
To carry 2' Walk around entire Structure

FIG. 2. DETAILS OF FRAMING FOR SECOND FLOOR OF CRIB.

In the jury's report the construction of the dynamite thawing apparatus in the crib was criticized, and it was shown that in the fire the rapid combustion of and dense fumes from the dynamite were largely responsible for the disastrous results. The contractor is now given the alternative of placing the dynamite thawing apparatus on the crib or on shore, but if the former plan is adopted the men must live on shore, the crib being used only for working purposes. If men are lodged and boarded at the crib, all partitions must be of fireproof material, and dynamite must be thawed on shore, being transported in jacketed buckets on the aerial wire tramway so as not to freeze during transfer to the crib. The thaw-house on shore, near 73d St., must also be reconstructed to conform to the requirements set forth in the article by Mr. Geo. F. Samuel in Engineering News, June 25, 1908. The storage magazine for explosives, off the lake front, near 73d St., must be illuminated by exterior lights, arranged so that the light is reflected through windows into the magazine.

The following requirements as to the construction and equipment of the crib are specified on the official drawings for the reconstruction of this structure:

Two separated stairways, at least 4 ft. wide, shall be built; they shall be made of fireproofed materials, completely enclosed with fireproof partitions, and shall be provided with wood-core, metal-covered, self-closing fire doors. All window frames and sash shall be of metal. All doors shall be metal covered. All partitions shall be fireproof. The elevator shaft shall be enclosed with fireproof partitions extending to the roof and with self-closing fireproof doors.

All exposed interior surfaces of side walls and ceiling shall be covered with Portland cement plaster on metal lath. This plastering shall extend in to all metal frames at openings and shall be backfilled at all joints. The head frame posts shall be protected by cement plaster in a similar manner and shall be provided with iron protection at the base (Fig. 1.).

All framing and bolting is to be thoroughly done. The stringers and beams shall be of yellow pine or Oregon fir. The 2-in. lumber forming the floor and roof shall be thoroughly dry, of uniform width and thickness, and straight edges. There shall be an iron ladder from a short distance above the first floor to walling timber on each side of each large door opening.

All wooden framework in the interior, above the first floor, shall be protected with plaster or metal covering. In the second story there shall be at least one window in each side of the crib and in each room. There shall also be one door leading to the gallery. Windows shall be not less than about 27 ins. in width, 27 ins. high and with sills not more than 3½ ins. above the floor.

There shall be supports for boats on all six sides of crib, and not less than three lifeboats shall be provided. The smokestack or chimney is to conform to city ordinances in regard to height, protecting thimbles, etc.

A Locomotive Firebox Without Staybolts in the Side Sheets and Crown Sheet.

Many important new ideas in locomotive design have been introduced from time to time on the Atchison, Topeka & Santa Fe Ry. One of the latest of these is a firebox which has no staybolts in the side or crown sheets. These staybolts (numbering several hundred in a large firebox) constitute, as is well known, one of the greatest troubles in the maintenance of locomotive boilers, as noted elsewhere in our editorial

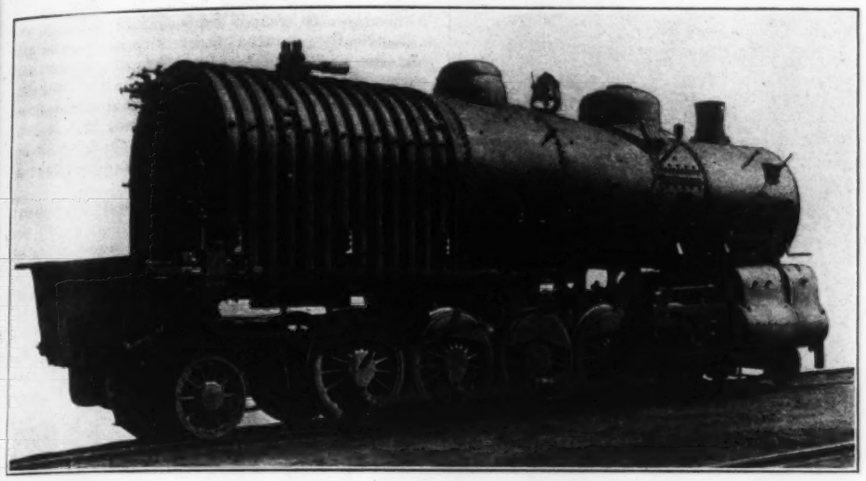


FIG. 1. LOCOMOTIVE WITH SECTIONAL CORRUGATED FIRE-BOX WITHOUT STAYBOLTS (JACOBS-SHUPERT SYSTEM); ATCHISON, TOPEKA & SANTA FE RY.

columns, but while many attempts have been made to reduce the troubles incident to their use, the staybolts have been regarded usually as a necessary evil in locomotive boiler design.

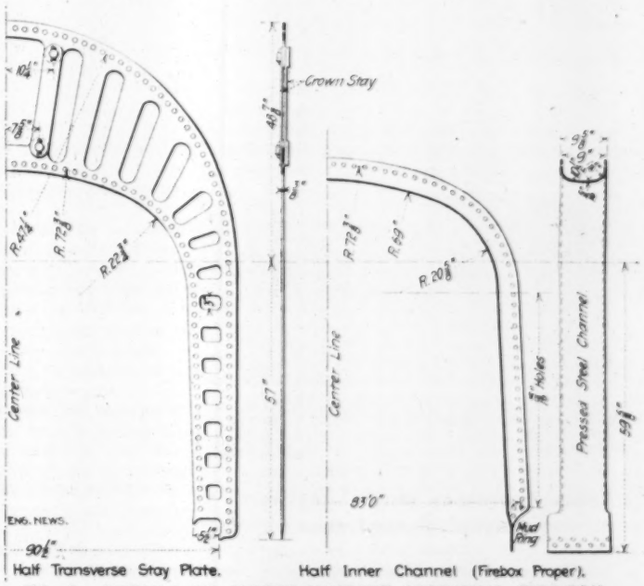
The new type of firebox mentioned above eliminates the large flat side sheets and their numerous staybolts, and substitutes a flexible arrangement which allows freedom for the irregular expansion and construction which take place in both the firebox and its outer shell. The construction is simple and less expensive than staybolt work. The firebox has been invented and patented by H. W. Jacobs, Assistant Superintendent of Motive Power, and Frank Shupert, Foreman Boiler Maker in the railway company's shops. The fireboxes are being made at these shops for several new engines, and the first engine thus equipped has been in service for three months, with satisfactory results. Fig. 1 shows this engine, with jacket removed. We are indebted to Mr. Jacobs for photographs, plans and other information.

The Jacobs-Shupert firebox is a radical departure from the usual type of construction. The firebox proper and the outer shell are each composed of a series of channels or flanged plates 10 ins. wide (with flanges outward), forming the sides and crown. The ends are riveted against the mud ring. The inner and outer channels are connected by transverse stay plates of horseshoe shape, which conform to the shape of the water leg and steam space, and are pierced with openings to allow free horizontal circulation of the water. These plates are fitted between and riveted to the flanges of the channels, and their edges form effective calking strips for making tight joints between the adjacent sections. The webs of the channels are slightly concave (inward for the firebox and outward for the outer shell), so as to give ample flexibility for expansion and contraction movements. The construction is shown in Fig. 2, and Fig. 3 is an interior view of the firebox.

As all the flanges face outward (from the center of the boiler), the sides of the firebox have no rivet or bolt heads exposed to the action of the fire. At the lower portions of the sides, the flanges of the channels are eliminated, so as to give a continuous smooth surface for application to the mud ring. The flanges are partially straightened and reverse lapped in such a way that the lap of one flange fits snugly into the lap of the adjacent flange, as is shown in Fig. 4. Three patch bolts are put through the lapped flanges, and the joint is made secure by welding the parts together by the autogenous process. The mud ring is of ordinary form, with a double row of through rivets. The joint at the mud ring has proved very effective under test and in service, and has given no signs of leakage.

The channels are made from long flat steel plates of the proper width, the plates being pressed while hot in formers under the hydraulic flanging press of the boiler shop. The edges of the flanges are then planed, with a slight bevel on the inner side. The channel is then heated and pressed to the required outline of the firebox or shell by means of other formers in the hydraulic press.

The transverse stay sheets (of horseshoe shape) are cut from ⅜-in. steel plates 98½ × 59 ins., and the openings in them are punched out under the hydraulic press. A large opening is made above the firebox crown, across which are two vertical sling stays attached to pins. With these stays removed, the opening is large enough to permit a man to pass through, and inspect the crown sheet. For simplicity in construction and economy of material, each stay sheet is made in three pieces, the two pieces forming the water-leg stays being cut from the waste material removed from the center of the crown stay plate. The shape of the stay sheet conforms to the contour of the inner and outer channels, to the flanges of which the plate is riveted. The tube sheet and door sheet conform to the contour of the flanges of the outer channels and form the end stay sheets. They have the same water leg and crown openings as the intermediate (horseshoe) stay plates, in addition to the tube holes in the tube plate and the door hole in the back plate. The throat sheet, connecting the outer shell with the boiler barrel, is made from a single plate. The throat sheet and the inner and outer back plates are pressed to shape by special formers in the hydraulic flanging press. Staybolts are used at the throat sheet and back sheets, as shown.



Half Transverse Stay Plate. Half Inner Channel (Firebox Proper).

FIG. 2. DETAILS OF JACOBS-SHUPERT SECTIONAL FIRE-BOX.

All channels, stay plates, etc., are pressed to shape by standard dies and formers, so that those of each shape are duplicates and interchangeable. The rivet holes in the stay plates and the flanges of the channels are drilled to standard templates, so that no preliminary laying out is necessary. The holes in the templates are fitted with case-hardened bushings made from soft steel. In construction, the inner or firebox channels are first riveted to the transverse stay plates, and then bolted to the mud ring. The seams are then calked. The channels of the outer shell are riveted between the stay plates, and the ends of both inner and outer channels are then riveted through the mud ring.

The riveting of the channels to the stay plates is done by a special hydraulic riveting machine designed and built at the railway shops and intended for working in close quarters. The riveter is of the elongated jaw or alligator type. It is suspended from a point immediately above its center of gravity, and is readily handled by the operator in adjusting it to place and shifting it from one rivet to the next. It has flexible hose for the feed and discharge connections. Fig. 5 shows this riveting machine at work.

The sectional form of construction and the concave shape of the webs of the channels provide for free expansion and contraction due to variations in temperature at different parts of the firebox. Each section is free to expand or contract without producing local stresses or transmitting undue stress to adjacent sections.

Horizontal circulation of the water is amply provided for by the openings in the stay sheets, and there is a large unobstructed area above the mud ring for circulation and for washing out any deposit. The vertical circulation, which is the more important, is practically free, the spaces between the two channels of each section being entirely unobstructed. This enlarged space, due to the absence of staybolts, encourages rapid vertical circulation, and the greater the rapidity of this movement the greater is the scouring action of the water in sweeping off the steam bubbles as they form on the hot surface. The corrugated surface of the fire side of the firebox is considered effective in causing a whirling and scrubbing action of the hot gases against the metal, which prevents the collection of a film of inert gas against the plate and thus tends to increase the evaporative value of the heating surface.

Among the several advantages claimed for this sectional form of firebox construction the principal are the following: (1) an exceptional degree of safety; (2) provision for expansion and contraction due to variations in temperature; (3) improved vertical circulation of water; (4) acceleration of the scrubbing action of the water

against the firebox; (5) increased heat transmission; (6) increased area of heating surface; (7) greater evaporation per unit of heating surface. As far as safety is concerned, it is claimed that a possible rupture would be confined to a single section, and that the effects of an explosion would be confined to the simple escape of the contents of the boiler. In case of failure in locomotive boilers of the ordinary type, it is the sudden tearing away of a large area of the crown sheet that causes violent explosions and disastrous results. With the sectional construction it is believed that this action is impossible, as a rupture could not extend from one section to another.

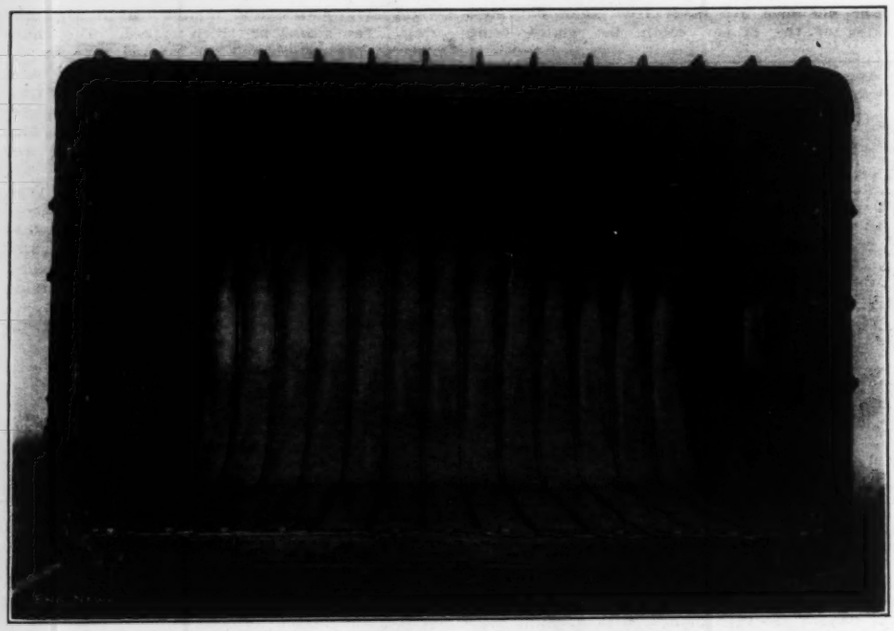


FIG. 3. INSIDE OF JACOBS-SHUPERT FIRE-BOX (STAYBOLTS IN THROAT AND BACK PLATES ONLY; NO STAYBOLTS IN SIDES).

The firebox now in use is on a four-cylinder (tandem) compound freight engine of the 2-10-2 class, which is shown in Fig. 1 ready for the lagging and jacket. It is used with oil fuel.

The firebox is to be applied to another engine of the class described, and to four Mallet compound engines now being built by the Baldwin Locomotive Works. The dimensions of the 2-10-2 freight engine equipped with this firebox are as follows:

Driving wheels, diameter	4 ft. 9 ins.
Wheelbase, driving	19 ft. 9 ins.
Wheelbase, total	35 ft. 11 ins.
Weight on drivers	234,580 lbs.
Weight, total	287,240 lbs.
Cylinders, HP. (2)	19 × 32 ins.
Cylinders, l. p. (2)	32 × 32 ins.
Boiler, diameter at first ring	6 ft. 6¾ ins.
Boiler, diameter at throat sheet	7 ft. 5¾ ins.
Boiler pressure	225 lbs
Tubes, No. 377; length	16 ft. 11⅛ ins.
Firebox, length	10 ft. 9⅝ ins.
Firebox, width	6 ft. 6¾ ins.
Firebox, depth	6 ft. 4⅝ ins.
Heating surface, tubes	3,589 sq. ft.
Heating surface, firebox	295 sq. ft.
Heating surface, total	3,884 sq. ft.
Grate area	68.2 sq. ft.

Annual Convention of the Engineers' Society of Pennsylvania.

The Engineers' Society of Pennsylvania, which as a state-wide organization has recently succeeded the Engineers' Club of Central Pennsylvania, has introduced a somewhat novel convention idea. This is nothing more nor less than organizing a Convention Section of the Society. All members of the society may become members of the Convention Section by declaring their intention so to do, and associate members of the society have the right to vote in the Convention Section.

The Convention Section had a three-days' meeting at Harrisburg last week. The convention differed from most, in that instead of papers and discussions the technical proceedings consisted largely, if not wholly, of rather lengthy lectures. By means of these lectures, reviews of various engineering fields were presented in considerable detail. Most of the lectures were obviously of such character as to make even an abstract of them out of the question here. Presumably all of the lectures will be published in the Journal of the society, which is being issued every month in the year.

One of the first objects of the leaders in the society is to formulate, as speedily as is consistent with due deliberation, an engineering code. An attempt to secure a legislative act regulating the practice of engineering in Pennsylvania failed at the last session of the legislature. It is said that the failure was largely due to lack of unity of ideas on the part of different members of the profession throughout the state. To remove this obstacle to legislation, and presumably at the same time to secure much more comprehensive and better considered legislation than was brought up at Harrisburg last winter, an effort will be made to secure cooperative action on the part of all the engineers and engineering societies of the state. It is thought that this can be done through cooperating committees of the various engineering societies and through the district or county committees of the main or state society, the organization of which, for this and other purposes, was one of the leading objects of the recent convention at Harrisburg.

To bring the subject of an engineering code before the engineers of the state in a concrete form was the object of the first paper presented at the convention under consideration. This paper was prepared by Mr. F. Herbert Snow, M. Am. Soc. C. E., President of the Engineers' Society of Western Pennsylvania and Chief Engineer of the Pennsylvania Department of Health. Mr. Snow's paper, entitled "Outlines for a Code with Legislative Backing for Pennsylvania Society of Engineers," is printed elsewhere in this issue.

The subjects dealt with in the various lectures given during the convention included mining engineering, concrete bridges, electric furnaces for the production of pig iron and of steel, sewage disposal, gas engines, preservative treatment of railroad ties, telephone construction, electric railways, roads and pavements, turbines and other subjects. Two special evening-lecture features were illustrated addresses on the Panama Canal, and on the United States Reclamation Service, by Lieut.-Col. [illegible] F. Hodges, M. Am. Soc. C. E., Corps of En[illegible]ers, U. S. A., Assistant Engineer Isthmian C[illegible]al Commission, and Mr. Arthur P. Davis, M[illegible]n. Soc. C. E., Chief Engineer U. S. Reclam[illegible]n Service, respectively.

We can note but a few points [illegible]rawn from two or three of the lectures. Firs[illegible]ve may state that the address on the "Rel[illegible]n of Electric Furnaces to Siderurgy," by Mr. [illegible] McNiven Binnis, included a description of an [illegible]ectric furnace for the production of pig iron in [illegible]alifornia. Local iron ore found in convenien[illegible] nearness to limestone, is treated by means [illegible] charcoal and electrically-produced heat, with [illegible] considerable saving over blast-furnace pig iro[illegible] at least with coal at such high prices as prev[illegible]l on the Pacific coast. A high grade of ch[illegible]coal iron results. The author also describ[illegible] in considerable detail three main types and [illegible] larger number of varieties of electric furna[illegible] for the production of steel.

Two lectures on sewage disposa[illegible] were given. The first was by Mr. Snow, and [illegible]dealt with the need of proper means of sewage disposal rather than with the several methods available. To show the need a number of typhoid epidemics

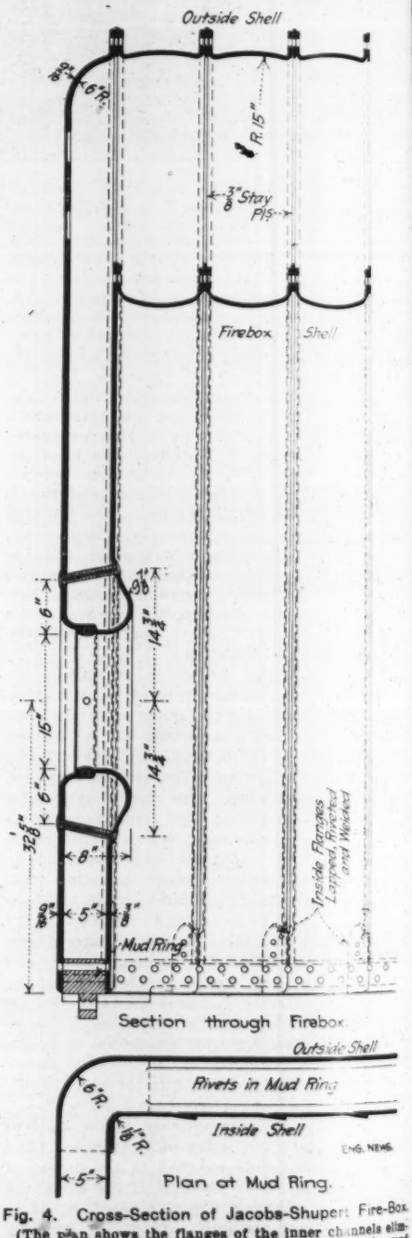


Fig. 4. Cross-Section of Jacobs-Shupert Fire-Box.

(The plan shows the flanges of the inner channels eliminated to form a flat surface for connection to the mud ring. The flanges are straightened, tapped, riveted and welded.)

in Pennsylvania were presented in outline and traced to improper methods or to lack of method of sewage disposal. Many of these typhoid outbreaks were due to contamination of the milk supply of one producer by water from a polluted source. A remarkable outbreak of gastro-intestinal affection at Warren, Pa., due to sewage poisoning, was described. Altogether this lecture by Mr. Snow emphasized anew and in a convincing manner the need for keeping sewage out of public water-supplies, and also of strict sanitary supervision of public milk supplies.

The second address on sewage disposal dealt with manufacturing wastes. It was presented by Mr. Frank A. Barbour, M. Am. Soc. C. E., of Boston. The author considered both separate disposal of these wastes and their treatment in conjunction with normal domestic sewage. The many and complex problems involved in this subject were outlined, and various eminently practical hints, based on the experience and study of the author, were given. Some extracts from this paper will be given in a later issue.

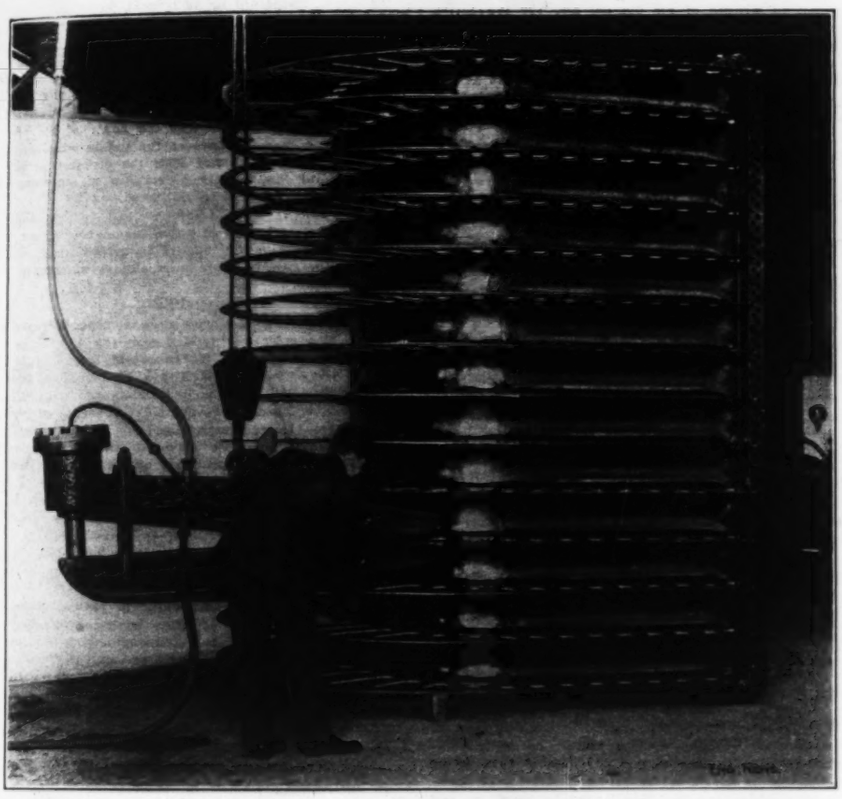


FIG. 5. RIVETING THE FIRE-BOX CHANNEL PLATES TO THE TRANSVERSE STAY PLATES WITH A SPECIAL HYDRAULIC RIVETING MACHINE.

An illustrated lecture on "Water Purification" was given by Mr. George A. Johnson, Assoc. M. Am. Soc. C. E., of New York City.

Mr. Johnson first gave a brief historical review of public water-supplies and purification, and also of the awakening to the need for water purification in the latter part of the 19th century caused by repeated typhoid and cholera epidemics. After taking up methods of water purification available and the efficiency of the two kinds of filtration now in use, Mr. Johnson gave the following interesting summary of the present status of water filtration:

> In 1904, according to Hazen, there were 560,000 people in America supplied with water filtered through slow-sand filters and 2,600,000 people were supplied with water filtered by mechanical filters. This corresponds to 9.7% of the urban population of the United States as being supplied with filtered water at that time. It may be of interest to point out that at the same time over 4,000,000 people in Japan were being supplied with water filtered through slow-sand filters, corresponding to 8.7% of the *total* population of that country. Since 1904 many large filter plans have been put into service in America, until at this time approximately 3,700,000 people are being supplied with water filtered through slow-sand filters and 3,900,000 people with water filtered through mechanical filters. This corresponds to over 21% of the urban population of the United States.

Among the larger plants which have recently gone into service may be mentioned the following:

English type.	Daily capacity, gals.
Philadelphia, Pa.	345,000,000
Washington, D. C.	75,000,000
Pittsburg, Pa.	140,000,000
Indianapolis, Ind.	20,000,000
New Haven, Conn.	8,000,000
Providence, R. I.	18,000,000
American type.	**Daily capacity, gals.**
Cincinnati, O.	112,000,000
Columbus, O.	30,000,000
Youngstown, O.	10,000,000
Hackensack, N. J.	24,000,000
Harrisburg, Pa.	20,000,000
Louisville, Ky.	36,000,000
New Orleans, La.	40,000,000

As to the cost of filtration, so far as it is possible to state this in general terms, Mr. Johnson said that the per capita cost for the construction of filtration plants in America is about $2 for mechanical filters and $3 for slow sand filters. The per capita cost of slow sand filter plants in Japan is about $3. These figures for construction cost do not include pumping equipments and large settling reservoirs. Per capita operation and maintenance costs, including all charges, are said by Mr. Johnson to range from 25 to 50 cts. per year.

A considerable portion of the paper was devoted to the subject of water sterilization, and much of this part was devoted to the Boonton plant. Mr. Johnson and others presented papers on this plant at the meeting of the American Water Works Association at Milwaukee last week, to which we propose to devote some space in a later issue.

Hypochlorite of lime, the sterilizing or disinfecting agent used for the Jersey City supply, has also been employed to treat the clarified water of "Bubbly Creek" at the Chicago stockyards. At this plant coagulation, sedimentation, treatment by hypochlorite of lime and filtration follow in the order named, and by means of the combination, Mr. Johnson stated, "the foul and putrescible waters of Bubbly Creek were rendered safe for primary uses." Copper sulphate was first used as a germicide at the Bubbly Creek plant,

> but it was found that while the initial germicidal action was satisfactory, the filtered water still contained high quantities of organic matter, which coated the sand grains in the filters and caused deposits in the piping and clear-water reservoir. These deposits were instrumental in propagating bacterial life so that the final effluent as delivered to the reservoir in the stockyards frequently contained many thousands of bacteria per cubic centimeter and possessed a noticeable odor of sewage. With the substitution of hypochlorite of lime these deposits of organic matter ceased, the final effluent lost its sewage odor, was clear, sparkling and well oxygenated, and the germicidal action was quite as, if not more, positive as when copper sulphate was used. As a whole, the results obtained were spectacular in the extreme.

An industrial exposition in a large hall was open to those in attendance at the convention. This exposition was brought together under the auspices of the society, and included a large number of engineering exhibits of a varied and interesting character.

Outlines for a Code With Legislative Backing for Pennsylvania Society of Engineers.*

By F. HERBERT SNOW,† M. Am. Soc. C. E.

I have framed the following suggestions for a code by request. These suggestions are only a basis for discussion. They are adaptations of the practice in law and medicine.

Introductory.

The stability of our form of government rests upon the approval of the people. It is fundamentally essential to that stability, that the conduct of affairs in all large matters, shall be so ordered and maintained, that the public shall have confidence in the integrity and impartiality of the system.

To meet this requirement, the learned profession of the law has established its code of ethics. So has the profession of medicine. The prestige of each is due in no small degree to the conduct and motives of individual members as influenced by the high standard of development of the code.

The great profession of engineering suffers in comparison in part probably because it has not organized, adopted a code and published its canon for the rule and guide of its members.

Our traditions have been defied and the tone of our high calling lowered because of lack of cooperation. To merit high regard of all men, engineers as a body must organize. To promote such an organization is the great object of this convention.

The problems of the development of the country and its resources, of investment in enterprises, of transportation on land and water, of power and light and heat, of building and maintaining cities, their food and water supplies, all these and more too numerous to mention, are the engineers' problems. To the profession, all men, women and children are personally indebted for benefits stupendous, indispensable and enjoyed daily. He not only plans and erects every kind of a structure and machine imaginable, but in the field of consultation and advice he has no second, excepting that of the lawyer; and no second when it comes to matters of investigation and report.

From this view point I offer as a basis for your consideration, outlines of a code with legislative backing.

The Duty of the Engineer.

The highest duty of the engineer to the public is to command the respectful attitude of all just men. This respect is not due primarily by reason of the incumbency of some office or the perfunctory performance of some professional engagement; but by reason of the importance of the service and the knowledge and integrity demanded.

Against unjust criticism and clamor the engineer cannot always defend himself. So he is peculiarly entitled to receive organized support. Thus may the honor of the profession be upheld. It is the privilege and duty of a member whenever there is proper grounds for serious complaint of an engineer, and not otherwise, to submit charges to a constituted tribunal. The person making a proper charge should be encouraged and protected.

The engineer should aid the organization in guarding against the admission to the profession of candidates unfit or unqualified by either moral or educational deficiencies. He should uphold the honor and maintain the dignity of the profession and strive to promote a universal regard for and observance of the code.

The engineer owes his best efforts, learning and ability to every employment. The client is entitled to entire devotion to his cause as hereinafter explained. No fear of disfavor or public unpopularity should restrain the engineer from the discharge of his duty once he has

*Presented to the Society, June 9, 1909.

†President of Engineer's Society of Pennsylvania, and Chief Engineer, Pennsylvania Department of Health.

advisedly accepted the employment. But this duty is universally one on the side of moral and statutory law. It does not demand or permit violation of law or disobedience of personal conscience.

The Selection of an Engineer.

In the selection of engineers for positions of public importance, it is the duty of the organization to endeavor, by approved means, to prevent political considerations from outweighing professional fitness. The compulsory selection and employment of qualified experts for responsible offices is not essentially different in principle from the civil service laws which have been declared to be constitutional in some of the states. Not only should the organization protest earnestly and actively against the appointment or election of those who are unsuitable for engineering positions of a public character, but it should strive to compel the foregoing of all other employment by the incumbent, which may embarrass his full and fair consideration of questions before him for decision, or which may place other members of the profession at a disadvantage. The office may not seek the man, but this need not deter the qualified aspirant from seeking to honor the office.

Relations With Members and Officials.

A member should not attempt to exert personal influence on an expert called in to arbitrate, or on any person before whom any act or opinion of the member is to come in official review.

The engineer should also use his best efforts to restrain and prevent his client from doing those things which the engineer himself ought not to do. And if the client persists in such wrong doing, the engineer should terminate their relation.

All personalities should be scrupulously avoided. The personal history or the personal peculiarities or idiosyncrasies of the officer, expert or opposing member should not be alluded to.

Cordial personal and official relations between the official and the member must rest on courteous self-respecting independence in the discharge of professional duty. Although the motive may be innocent, nevertheless marked hospitality or attention, uncalled for by the usual personal relations of the parties, subject both to criticism that should be avoided. Special personal consideration or favor cannot be tolerated. Attempts to give or obtain the same should be rebuked and denounced.

The merits of a pending cause should not be argued by word or letter, by an engineer who is party to the cause, except in the legally prescribed manner. An observance of this rule of conduct should save much embarrassment. Newspaper discussion by the engineer of pending problems and reports upon which he is engaged is condemned. The extreme circumstances of a particular case may justify a prudent and limited statement to the public but never an anonymous statement.

When called upon to arbitrate a just personal matter for another, no trivial excuse should obtain with the engineer. His best efforts should be at the disposal of an unfortunate professional member.

Experting a Cause or Defense.

In experting any cause or defense within his capacity where his employment approaches the nature of an advocate, the personal opinion and the professional opinion of the engineer are and must be one and the same. Where new facts and witnesses, perhaps hitherto suppressed or secreted, establish fairly and honestly in his opinion the serious error of his premises, his duty may be to withdraw without prejudice to his client. He should not resort to device of artifice to hide his personal views. His primary duty is to stand for the truth as he knows it. Any other course is highly reprehensible.

However, it is the right of the engineer, if he be free to do so, to accept employment by any one regardless of circumstances or cause, provided he be permitted to render untrammelled professional service.

Retainers and Employment.

It is the right of the member to accept a retainer, only when he shall be satisfied, after full and particular inquiry, that the circumstances of his relations to, interest in, or connection with the parties to the controversy, pending or imminent, permit him to serve the client with undivided fidelity.

It is unprofessional to divulge, at any time, the secrets or confidence of a client. To do so harms the member and the profession most. This prohibits the subsequent acceptance of a retainer or employment adversely affecting any interests of the client with respect to which professional confidence has been reposed.

Upon express consent of all concerned, it may be professional for a member to represent conflicting interests, but not often. And never, when in behalf of one client, his duty—apart from justice under the law—is to present information which duty to another requires him to withhold.

Consultation.

An engineer called in consultation by a client should decline association as colleague if it is objectionable to the other engineer. But if the engineer first retained is relieved another may come into the case. Lack of confidence is not necessarily implied by client's use of privilege to engage additional professional advice.

When engineers jointly associated in a case cannot agree as to any matter vital to the interests of the client, the client's final decision should be accepted unless the conflict of opinion makes it impracticable for the member whose judgment is overruled to cooperate effectively. Whereupon his duty is to ask the client to relieve him.

A client seeking relief against unfaithful or neglectful service under contract, the nature of which does not admit of immediate dismissal, may be properly advised by an engineer without fear or favor, after communication with the member of whom the complaint is made. But efforts, direct or indirect, in any way to encroach upon the private business of another, are unworthy of members of good standing in the profession and inimical to the interests of engineers and the public.

Advice.

Before advising upon the merits of a proposition the engineer should endeavor to obtain a full knowledge of the problem. Extended investigation or experiment may be required. Whatever the preparation for report in a case may be, the engineer should give a candid statement in writing of his opinion and the foundation therefor.

Where the undertaking of an enterprise depends upon the favorable report of an engineer, the surprises, disappointments, or unforseen difficulties incident to human endeavor, should admonish the member to be slow to make confident assurances, more especially if further employment or profit to the engineer may depend upon such assurance. The force of this is emphasized whether the member owns or purposes to acquire an interest in the venture.

The responsibility for advising and urging questionable transactions is the engineer's responsibility. He cannot escape it by offering the excuse that he is following his client's instructions. This relation should not be confounded with that where the service is technical and devoid of advice or advocacy.

Negotiation.

An engineer representing a party in some dispute or matter of negotiation, is entitled to and should receive all the consideration due his station; and no negotiation or compromise by the engineer of the opposite party should be undertaken over his head. The engineer should not take undue advantage of a second party to an agreement. As far as possible important agreements affecting the rights of clients should be reduced to writing. But it is dishonorable to avoid performance of an agreement fairly made because it is not reduced to writing.

Whatever may be the ill feelings existing between clients, it should not be allowed to influence engineers in their conduct and demeanor towards each other or towards other people.

Amount of Fee.

In fixing fees the engineers should avoid both overcharges and under-charges.

A client's ability to pay cannot justify a charge in excess of the value of the service. His lack of means may require a less charge.

The reasonable request of a brother engineer and of his widow and orphans without means, naturally commands special consideration. This class of case where fees are sued is not unusual.

The amount of the fee should not be fixed by any method that eliminates considerations which are the proper guides in ascertaining the real value of the service. Some of these considerations, no one of which may be controlling, are:

(1) The time and actual labor required and the expenses to be incurred; the novelty and difficulty of the questions involved and the skill demanded in the solution of the problem or execution of the project.

Competitive lump sum bidding is diametrically opposed to these principles of compensation. It cheapens the service and the profession, opens avenues to temptation and deserves the united opposition it invites.

(2) The question whether the employment precludes the subsequent employment of the engineer by others in cases likely to arise out of the particular case, in which there is a reasonable expectation that otherwise he would be employed, or the question whether the employment involves loss of other business or antagonisms with other clients.

(3) The customary charges for similar services by reputable members of equal professional standing.

(4) The amount of money involved, or the extent of the interests concerned, and the benefits resulting to the client from the service.

(5) The basis of payment, whether contingent or certain.

(6) Whether the employment is for an established constant client or for a casual client.

In fixing fees it should never be forgotten that the engineer is a professional man, not a wage earner on a day and hour schedule of labor and pay. He is entitled to receive reasonable recompense for his services, compatible with his self-respect, station and true importance in the community. Nothing operates more certainly to deprive the profession of the full measure of public esteem and confidence than does the imposition and injustice of ridiculously small compensation for responsible services of an every-day character as well as for services of marked distinction.

General Conduct.

The professional conduct of the engineer should be characterized by candor and fairness. The concealment or withholdment of facts and information from those entitled to receive them is dishonorable and unprofessional.

He should not offer a plan or design or advice or suggestion or give any evidence which he knows should be rejected; nor should he argue or testify from a premise known to him to be false.

In all incidental matters not affecting the merits of any cause, he should be guided by proper solicitude for and consideration of the rights of other members of the profession. No client has a right to demand that the engineer shall be illiberal in his conduct or that he stoop to abuse or minister to the prejudices of the client. He cannot be the keeper of the engineer's conscience. The engineer's own sense of honor and propriety must govern.

No client, corporate or individual, however powerful, nor any cause, civil, or political, is entitled to receive any service or advice involving disloyalty to the law or the engineering profession which the members are bound to respect and uphold. When rendering any such improper service or advice, the engineer invites and merits stern and just condemnation.

Correspondingly he advances the honor of his profession and the best interests of the public when he renders service in compliance with the strictest principles of the moral law and in observance of statutory law as it is construed and administered.

No more is it true of lawyers and doctors, than of the engineer, that "he will find his highest honor in a deserved reputation for fidelity to private trust and to public duty, as an honest man and as a patriotic and loyal citizen."

Advertising.

There are legitimate ways of advertising for the engineer. The most worthy and enduring way, especially with brother engineers, is the establishment of a well merited reputation—the outgrowth of character, conduct and achievement. This cannot be forced.

However, engineering covers many branches and where the engineer has commercialized his services, ordinary business methods may be invoked without prejudice to himself, depending on prudence of judgment in methods used.

The solicitation of business other than commercial, by circulars, personal correspondence or interview, not warranted by personal relations, is questionable but not necessarily unprofessional; but it is unprofessional to procure such business through hired agents or by offering retainers in exchange for commissions.

The membership in and reading of papers before scientific societies and participation in discussions, and the inspiring of written accounts in engineering journals of work accomplished by the engineer, are legitimate ways open to the member of extending his reputation. But above all the engineer will find his greatest benefit in organization and cooperation. Thus will traditions no longer be defied and the tone of our high calling be restored.

Admission to Practice.

In determining what rules shall govern in admitting candidates to practice in Pennsylvania, the first requirement is time in which to deliberate the question.

Laws regulating the practice of engineering must follow. The code alone implies a law back of it.

Standards of proficiency in every branch must be adopted. Practical experience and knowledge must count. Men now practicing engineering should not be legislated out of a livelihood. Educational training for specialties must also count. The compulsory employment of men properly qualified for the positions, where public safety, health or welfare is concerned, is not civil service; but it is a movement comparable with that regulating the practice of law and medicine.

Conclusion.

Shall it be considered too much to demand that every member of the profession shall be required to subscribe to the general principles which should ever control the engineer in the practice of his profession, as set forth in an oath of admission to the association—by each county if you choose—and conforming in the main to the duties of engineers as defined by statutory enactments, for the wilful violation of which dismembership is provided? I submit this and the entire subject to your earnest consideration.

You will deliberate the various matters through district committees representing the several branches of the profession and also collectively at the annual meetings of the Society and out of it all will be brought forth finally a code and draft of bills which shall subserve the interests of the public. We should ever remember that no permanent success can attend these efforts if the code be the instrument for the advancement of selfish interests.

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Entered at the New York Post-Office as Second-Class Matter.

The accident to the Canadian Canal lock gates at the Sault Ste. Marie last week, is the first very serious accident through collision of a vessel with the lock gates that has ever occurred at the Sault during all the years the canals there have been in operation. The detailed circumstances of the accident are set forth elsewhere in this issue and need not be repeated here. It is worthy of note, however, that, although three large vessels were caught in the torrent which started when the lock gates were knocked out and the flood swept down through the lock, only one vessel was seriously injured and that one is by no means a total loss.

As for the injury done to the canal, that was confined to the wrecking of two pairs of the lock gates. The irrepressible "New York Press" however, in its anxiety to twist a condemnation of the Panama plans out of the occurrence, declares that "the immense power which was thus unchained wiped out the lock."

It then proceeds to the following vivid word painting of the terrible things that would happen at Panama if a similar accident should occur there:

> There would be no earthly power to stop the gigantic instrument of destruction, swelling as it swept along, until it had leaped into the ocean's vast mass, after brushing the Isthmus of Panama off the map in a destruction by uncontrollable waters that has never been known since the flood of Noah's day.

"Brushing the Isthmus of Panama off the map" is about as wild an exaggeration as the statement that the Canadian lock was "wiped out"!

Actually it seems to us this Canadian accident is rather an object lesson, showing that while the opening of a lock by destruction of its gates would be a serious accident, it would not constitute after all any such terrible cataclysm, with results impossible of remedy, as has often been pictured.

When the Sault locks were built, the possibility of just such an accident as this that has now occurred was foreseen and movable dams were provided on both the Canadian and American sides, so that in case the lock gates should be carried away and a mill-race with Lake Michigan behind it set running through the locks, it would still be possible to shut off this flow and permit the gates to be repaired or replaced.

These movable dams have been operated for practice only, by the lock-tending force at various times, but the emergency for which they were built has never arisen till the present time. Criticism will doubtless be heard now of the fact that some difficulty has been found in operating the Canadian movable dam to shut off the flow. We desire to point out in this place, therefore, that this very difficulty has long been foreseen. It has been well understood by engineers, expert in canal lock design, that difficulty was likely to arise in forcing down the last wickets of the movable dam; after the flow had been checked enough to make considerable head for the water in the passage past the dam. At the Sault, however, it has never been deemed worth while to alter the movable dams, as originally designed and built. There has been some tendency to look upon their provision as an unnecessary superfluity and example of engineers' extravagance. At Panama, however, the details of the movable dam have been so planned as to remove the difficulty experienced at the Sault last week and enable the dam to be operated with certainty even with a high head.

However, the contingency of the destruction of lock gates at Panama and consequent flood is rendered so remote as to be hardly worth consideration by the provision of duplicate guard gates and guard cables and particularly by the introduction of towing systems by which vessels will be hauled into and through the locks by electric towing engines traveling on the lock walls. These engines will make it unnecessary for a ship to use its own engines in the locks and there will be no opportunity for accident through misunderstanding of orders by the man below deck, such as caused the accident at the Sault.

The almost universal practice in the United States heretofore has been to put upon the industrial workman and his family the whole or nearly the whole of the risk and expense due to industrial accidents, unless it can be proven that the accidents have been "due to the negligence of the employer (or of a superior fellow-servant) to which the negligence of the employee has not contributed."

The foregoing words are quoted from a portion of one of two papers on employers' liability, which we reproduce in part elsewhere in this issue. The second of the papers deals in a most earnest and forcible manner, which can scarcely fail to convince disinterested persons, with the injustice which is done to the workman and those dependent upon him, through the present American law and practice. It seems needless for us to attempt to add anything to the eloquent presentation of this subject made by Miss Eastman—a member of the New York Bar, whose work in this field has been highly endorsed and commended by Mr. Adelbert Moot, President of the New York Bar Association.

We may, however, restate the opinion which has already been expressed in these columns, that the rack and ruin of the human machine employed in industry is at least as fit a subject for charging against production as is the wear, tear and final scrapping of the inanimate machinery.

But there is an aspect of this question concerning employers' liability laws of even greater importance than the suffering of the injured working man, and those dependent upon him. In last week's issue of the "Outlook," a prominent attorney makes a most telling presentation of the evils now resulting from the law's delay. Instance after instance is given where resort to the courts has resulted in a delay, not of months, but of years, and in substantial denial of justice; and when we seek the cause of this delay and this congestion of the courts, we find it immediately in the vast volume of litigation over accident cases.

At the Ninth Annual Meeting of the National Civic Federation, in December last, Mr. William J. Moran, a prominent attorney of New York City, declared that not less than 60% of the business of New York courts is taken up with negligence suits. In the County of New York alone, only one of the four counties constituting the Greater City of New York and only one of the 61 counties of the entire state, the taxpayers spent over $4,000,000 last year, to maintain the judicial system, in salaries alone. In that one county over 40,000 business men were drawn for jury duty and had to suffer the loss and inconvenience of court attendance.

Sixty per cent. of this burden on the taxpayers and on business men is due to our pernicious and antiquated employers' liability laws. Mr. Moran declares that the confidence of the people in their courts is being undermined, and well it may be, when, as he says, 60% of the court's time is devoted to suits in which "technical and obsolete rules are invoked to defeat demands for reasonable compensation for the afflicted, and, on the other hand, arbitrary and ill-considered liability laws drive the sense of charity and justice from the hearts of employers."

In recent years, the various amendments have been made to the employers' liability laws for the purpose of increasing the employers' responsibility; but little benefit has resulted to injured workmen. In the great majority of cases, technicalities are successfully invoked to defeat their claims; and in the few instances where success finally occurs, the great bulk of the payment received is swallowed up by the expenses of litigation.

Mr. Moran, speaking from personal experience, says that his own firm had in the past five years been concerned in the defense of about 6,000 suits for negligence, and the average payment which was finally assessed was only about $300. The average retainer fee alone of the plaintiff's lawyer is almost 50% of this amount. This may indicate how little recompense the injured workingman receives under the present system.

The desirability of temporarily abandoning portions of city streets with a view to increasing the facility and economy of carrying on the construction of large sewers, rapid transit subways, etc., was noted in this column in our issue of June 3. It is of interest to note that a step in this direction has been made in the reconstruction of the Chicago street railways. The general method employed is to close one side of the street to vehicle traffic for a distance of four or five blocks, and to lay a temporary track on the surface of the street along this vacant strip. At street intersections, of course, this track is lowered to the grade of the cross street. On each side of the street intersections a plank paving is laid between the sidewalk and the temporary track, for the accommodation of passengers entering and leaving the cars. The old track next to the temporary track is then torn up, and the work of reconstruction is carried on systematically by successive gangs working from one end of the section to the other. This work includes the excavation, grading, concreting, tracklaying, rail-joint welding, and paving. When all this is completed, the new track is put into service, and the temporary track is moved ahead to another stretch of the street. Later, the same methods are repeated on the opposite side of the street. Electric cars bring the supplies of material, and a portable concrete mixing plant travels on the new track. This method, as introduced on some of the outlying streets, was noted in our issue of Nov. 7, 1907; but it has been (and is being) used also in the busy downtown streets. On some of the narrower cross streets, one track at a time has been abandoned (sometimes both tracks) and the cars diverted over another route, one side of the street being given up to the construction work, storing of material, etc.

Of course the method described causes some inconveniences for buildings on the closed side of the street. Coal has to be dumped at the nearest cross street and conveyed to the coal chutes in wheelbarrows; ashes are removed in the same way. But these inconveniences are very little, in comparison with the facility of performing the work and the advantage of keeping the routes of the cars on important lines unchanged.

A Supreme Court Decision on the Validity of Patent Claims Covering Mechanical Processes.

A notable decision was handed down by the Supreme Court of the United States on June 1, sustaining the validity of one of the basic patents on the manufacture of expanded metal. The patent contains but a single claim, and that claim is not for a mechanical combination, but is what is commonly known as a method or process claim. The claim reads as follows:

> The herein described method of making open or reticulated metal work, which consists in simultaneously slitting and bending portions of a plate or sheet of metal in such manner as to stretch or elongate the bars connecting the slit portions and body of the sheet or plate, and then similarly slitting and bending in places alternate to the first-mentioned portions, thus producing the finished expanded sheet metal of the same length as that of the original sheet or plate, substantially as described.

The patent in question was issued to John F. Golding, Oct. 9, 1894, No. 527,242. In the earlier production of expanded metal, the sheet was cut and opened, but there was little stretching of the metal forming the strands. The product of those earlier processes was a sheet of expanded metal much wider than the original sheet from which it was cut, but also much narrower. By the new method of working, the sheet was not shortened and the strands were regular. The new method has largely displaced the old.

The case was brought before the Supreme Court through conflicting decisions by the Circuit Court of Appeals. The Circuit Court of Appeals for the Eastern District of Pennsylvania held the patent to be invalid; the Circuit Court of Appeals for the Northern District of Ohio, however, sustained the validity of the patent.

The Supreme Court, after reciting the chief facts in the case, says in its decision:

> The important thing in this patent is a method of procedure, not the particular means by which the method shall be practiced. Golding's machine patent was not applied for for more than a year and a half after the issue of the patent in suit.

It was argued by the parties opposing the sustaining of the patent that a patent claim upon a process is valid only in the case of inventions having to do with chemical action or some similar elemental process, and that process claims are not valid for operations effected by mere mechanical combinations.

In discussing this claim, the Supreme Court quotes the Act of Congress establishing the patent system, as follows:

> Any person who has invented or discovered any new and useful art, machine, manufacture, or composition of matter, or any new and useful improvement thereof . . . may obtain a patent therefor.

The court proceeds to discuss at length the question whether a mechanical process can be made the subject of a valid patent, and quotes several decisions and authorities sustaining the right of the inventor to have a new mechanical process protected. "It is undoubtedly true," says the court,

> that the mere function or effect of the operation of a machine cannot be the subject matter of a lawful patent. But it does not follow that a method of doing a thing, so clearly indicated that those skilled in the art can avail themselves of mechanism to carry it into operation, is not the subject matter of a valid patent. . . .
>
> We therefore reach the conclusion that an invention or discovery of a process or method involving mechanical operations, and producing a new and useful result, may be within the protection of the Federal statute, and entitle the inventor to a patent for his discovery.
>
> We are of opinion that Golding's method was a substantial improvement of this character, independently of particular mechanisms for performing it, and the patent in suit is valid as exhibiting a process of a new and useful kind.

This decision is likely to have an important influence upon the development of the American patent system. Doubts concerning the validity of method or process claims for new mechanical operations have been so general, and have been so generally held by the Patent Office Examiners, that the tendency in recent years has been to reduce patent claims solely to combinations of elements. In many very important inventions, however, the thing really invented is the new method of working; and the fact that a patent claim for the new method will be sustained as valid by the highest courts is one of much importance to every inventor and manufacturer.

The Strength of the Queensboro Bridge.

With bands of music and blazing fireworks (the money for which was raised by a bond issue!) New York City celebrated last Saturday the formal opening for public traffic of the new Queensboro bridge. Notwithstanding the technical discussions concerning the margin of safety in the design of this bridge, the public evidently has full confidence in its strength and security.

Probably it is fortunate that this is the case. Good engineering work and sound engineering judgment are as often hampered by public panic over remote dangers that are not worth taking into account as by overconfidence of the public in works that are on the verge of failure.

The case of the Blackwell's Island or Queensboro bridge is emphatically one in which the expert, and the expert alone, can give intelligent judgment as to where the point of reasonable safety lies.

The engineering profession will follow with interest, we are sure, the additional reports upon this bridge which are presented in this issue by Mr. F. C. Kunz, the Chief Engineer for the contracting firm which built the bridge and a former Consulting Engineer of the New York City Bridge Department, together with the report by an able Commission on the matter discussed in Mr. Kunz's report.

It should be said here that while the pamphlet containing these reports is issued by the Pennsylvania Steel Co., which fabricated and erected the superstructure, that company was in no way responsible for the design of the bridge, and the material and workmanship—for which it *was* responsible—received high praise in the reports of Messrs. Boller & Hodge and Prof. Burr, which we published last November.

Nevertheless, the public, and even the engineering public, does not always properly discriminate. That the criticisms of the design made in and on the strength of the expert reports reacted more or less upon the contractor is probably true. It is proper to note, therefore, that Mr. Kunz's report, with the report of the reviewing commission, is in effect a justification of the design. We regret that this formal justification does not proceed from the Bridge Department engineers, since they should speak with best authority. However, they still have an opportunity to be heard.

The opinions of the reviewing commission agree with Mr. Kunz's stated belief that the bridge is adequate to carry all the lines of traffic contemplated in the complete design. This means four elevated-railway tracks in addition to the trolleys, roadways and footwalks. But Mr. Hodge was unable to find warrant for using so much as a single elevated track, and even Prof. Burr would permit only two tracks. These three very divergent findings are based on substantially identical dead-weight conditions, i. e., a reduction of the excessively heavy pavement, railings, concrete work, etc. We therefore face a direct conflict of opinion, with a range of variation of four tracks, amounting to about half the total live-load.

Into this disagreement between experts we shall not, for the present at least, enter. Since the Bridge Department has taken the responsibility of opening the bridge to the public, anything which might arouse public anxiety and conduce to possible panic upon the structure is to be deprecated.

This much, however, we feel compelled to say, since it concerns not the Queensboro Bridge alone but the design of large bridges generally: That the engineering profession at large would welcome better information gained from actual tests, of the strength of large compression members, such as the bottom chords of this bridge.

We find nothing in either Mr. Kunz's report or the Commission's to establish the reliability of the design of these compression members. Nor to be frank, did we expect to find anything. Mr. Kunz has a few words upon this subject, the substance of which is that our knowledge of compression members is, he thinks, no more inaccurate than our knowledge of girders or tension members.

In our opinion a certain cloud of uncertainty will hover over all discussions of the strength of this largest of American cantilever bridges until tests of large sized columns are available.

The Design of Locomotive Fireboxes.

The design of locomotive fireboxes has long been a subject for discussion and much difference of opinion among locomotive designers.

The old style firebox was narrow and deep, fitting between the frames, and it gave very fair results both in efficiency and durability, particularly where the water used was free from scale. One of the earliest departures from this form was the enormously wide and long firebox designed by Mr. Wootten to provide the large grate area necessary for burning the anthracite culm of Pennsylvania, a fuel so fine that it would be blown off the grates if it were attempted to burn it in grates of ordinary size. The Wootten firebox, however, has far too large a grate area to give economical results with ordinary fuel, and is expensive to build and maintain.

The first step to secure enlarged grate area on locomotive boilers of ordinary type was to raise the firebox and place it over the frames. In this position, however, it was still limited by the distance between the backs of driving wheels. The next step was to raise the grate level still higher, so as to clear the tops of the driving wheels, or to move the driving wheels farther forward and so permit the widening of the grate to any extent, limited only by the clearance limits of the roadway. Fireboxes from 6 ft. to 8 ft. wide and from 7 ft. to 9 ft. long were introduced. A report on boiler design presented at the convention of the Railway Master Mechanics' Association in 1901 contained the following statements:

> The wide firebox is rapidly becoming recognized as a standard form of construction. Fireboxes have about reached the limit of size both from the clearance standpoint as well as that of operation.

Some examples of these wide boxes are noted in the accompanying table. These were all for bituminous coal, but those of the Chicago, Burlington & Quincy Ry. and the Bismark, Washburn & Great Falls Ry. were for lignite also, while that of the Chicago & Eastern Illinois Ry. was a Wootten firebox for bituminous run-of-mine coal. Most of these wide fireboxes were deeper than the Wootten fireboxes, permitting a longer flame way, as a thicker fire is required with bituminous lump coal than with anthracite waste. Their depth averaged about 5 ft. 6 ins. The regular Wootten firebox was tried on both the Chicago, Burlington & Quincy Ry. and the Union Pacific Ry., but did not prove satisfactory with bituminous coal as might indeed have been expected. The life of these fireboxes under the above conditions was only about half that of the ordinary fireboxes used on the same railways.

The "wide firebox" idea, however, was undoubtedly carried to an extreme, and the present tendency is towards less extravagant proportions. Experience indicates that ample grate area may be obtained with a medium width of firebox (say about 5 ft.), which will at the same time avoid certain disadvantages shown to be possessed by the firebox of 6 to 7 ft. in width.

The very wide fireboxes are found to have a relatively short life (as compared with those of moderate width), thereby increasing materially the cost of repairs and the idle time of the engine. These features were discussed last winter before the Western Ry. Club in a paper by Mr. C. A. Seley, Mechanical Engineer of the Chicago, Rock Island & Pacific Ry. Mr. Seley intimated (what we have noted above) that the good steaming qualities of recent engines with comparatively narrow fireboxes indicate that designers have been too liberal (in some cases at least) in providing large width and area of grate for modern locomotives.

One of the special troubles with the wide fireboxes on several roads has been the short life of the side sheets as compared with those of narrower boxes, involving a large increase in the maintenance and repair expenses. It was this trouble which led Mr. Seley to make a study of the conditions and remedies. Among other matters he investigated the conditions of water cir-

EXAMPLES OF WIDE FIREBOXES FOR BITUMINOUS COAL.

Railway.	Firebox at Grate—Width ft.	Width ins.	Length ft.	Length ins.	Side sheets slope from mud ring.	Eng. News.
C. & E. I.	8	0	9	0	Curved; inward	Nov. 15, 1900
C., B. & Q.	6	0	7	0	Flat; inward	May 30, 1901
L. S. & M. S.	7	0	7	0	Curved; ellip.; inward.	Apr. 11, 1901
C., R. I. & P.	5	10	9	0	Curved; inward.	July 11, 1901
Bis., M. & G. F.	7	0	8	0	Flat; inward.	Apr. 17, 1902
A., T. & S. F.	6	7	9	0	Flat; inward.	Apr. 24, 1902
C., C., C. & St. L.	6	4	8	1	Flat; inward.	Oct. 23, 1902
Chicago & Alton	6	0	9	0	Flat; inward.	May 28, 1903
Wabash	5	3*	8	6	Vertical.	Mar. 17, 1904
A., T. & S. F.	5	6*	8	11	Vertical.	Mar. 31, 1904

*The last two cases indicate the tendency to change from an extreme width to a more moderate width, without reverting to the old narrow firebox.

culation over the side sheets of wide fireboxes, these sheets being necessarily inclined inwards from the bottom or mud ring. This arrangement would seem at first to be advantageous in keeping a solid body of water against the firebox sheet, so that the steam bubbles can escape upward rapidly and not tend to cling to the sheet and form a film between the metal and plate, which condition of course leads to overheating and injury of the plate.

As a matter of fact, however, it appears probable that the upward movement of these bubbles and the downward movement of the water in the water legs of such fireboxes may interfere with each other so as to check the circulation of water, cause the legs to fill with foam and the side sheets to become overheated. On the basis of his investigations Mr. Seley concluded that better circulation of both steam and water may be obtained by sloping the side sheets outward from the mud ring. The principle of this arrangement is that the course of circulation will then tend to detach or sweep off the bubbles as rapidly as they form, and to replace them with solid water. Such an arrangement necessarily involves a reduction in width of grate, but (as already shown) it appears that this can be done without necessarily reducing the steaming efficiency of the engine, while at the same time it effects certain advantages in regard to economical service. The inward inclination of side sheets was suggested in 1905 by Mr. L. H. Fry in a paper read at the convention of the Railway Master Mechanics' Association. The advantages claimed were better circulation and freer escape of the steam from the inside sheet, in the manner described. In the discussion at that time, however, Mr. Deems, of the New York Central Ry., spoke of experience with side sheets burning out in five or six months in wide fireboxes having a decided inward inclination.

A few years ago the motive-power department of the Chicago, Milwaukee & St. Paul Ry. conducted an investigation as to the relative repairs of narrow and wide fireboxes, the result of which was to show that the former were far the more economical in this respect. In the description of a powerful passenger locomotive of the 4:6:2 type built at the above company's shops (Engineering News, March 15, 1906,) it was stated that experience with wide fireboxes on this road had not been satisfactory, and that the narrow types had been reverted to in all new engines. The main troubles were the short life and excessive repairs of the former, in regard to both the sheets and the staybolts. In some cases the sheets of wide fireboxes lasted only from 12 to 18 months, while those of narrow fireboxes on engines on the same division lasted about eight years. The narrow firebox of the engine in question was of the ogee section, 3 ft. 5½ ins. wide and 10 ft. 5⅛ ins. long at the grate.

Since then, however, a new type of firebox has been developed on that road, with a width of about 5 ft. at the grate. A special feature of this new design is that the sides are flat or straight, but slope slightly outward from the vertical. Fireboxes of a generally similar character are in use on other railways.

In discussing Mr. Seley's paper, Mr. J. F. DeVoy, Assistant Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul Ry., expressed the opinion that with this outward inclination of the side sheets, the cooler water flows down against the inside sheet, and is not interfered with by the stream of the steam bubbles as they flow upward from the inside sheet. If the inside sheet slopes inward, as in very wide fireboxes, there is mutual interference between the descending water and the rapidly ascending steam bubbles, in the manner already suggested.

In support of his argument, Mr. DeVoy stated that of 18 passenger locomotives of the 4:4:2 class with narrow (42-in.) fireboxes, only four have had new door, tube, crown or side sheets in ten years. Of 28 engines of the same class with wide (66-in.) fireboxes, each had had at least one new sheet in seven years and some had had as many as three sets of side sheets in that time. In one year, 140 staybolts were applied to the narrow boxes as against 585 in the wide boxes. The latter have shown to somewhat better advantage in freight engines of lower speed, as was stated by Mr. DeVoy in discussing this subject at the annual meeting of the Master Boiler Makers' Association in 1906. Of 16 freight locomotives of the 4:6:0 class built in 1900, and having narrow fireboxes, all retained their original boxes in 1906. Of 66 locomotives of the same type, but with wide fireboxes, built during 1901 to 1903, 14 had had new door, tube, crown and side sheets in 1906. Tubes lasted nearly twice as long in the narrow boxes. During 1½ years there were 152 new staybolts applied to the narrow boxes, as against 1,127 for the wide boxes. The engines with narrow boxes also averaged a saving of 0.11 lb. of coal per 100 ton-miles, due to the large grate admitting more air than is needed for combustion, and to the fact that the firemen use the coal more liberally. In fact it was considered that many of the cases of leaky tubes and cracked side sheets could be traced to irregular firing in the wide boxes.

A highly novel and radical plan for doing away with the troubles incident to firebox side sheets as well as a large part of the trouble with breaking staybolts is offered by the Jacobs-Shupert firebox, now being tried on the Atchison, Topeka & Santa Fe Ry., and described on another page of this issue.

Here the firebox and outer shell are composed of arched channels forming the sides and crown; they are connected by transverse stay plates or diaphragms which extend across the water leg and are riveted between the flanges of the channels. Openings in these diaphragm plates provide for horizontal circulation of the water. The spaces between these staybolts are entirely free from obstruction to the vertical circulation.

The design of this firebox has been under consideration for some years, and has been modified from time to time to meet various criticisms and suggestions; but it is considered now to be thoroughly practicable for everyday conditions of railway service. One large freight locomotive with this firebox is now in service and several more, we understand, are being built.

We are not informed as to the cost of this firebox; but apparently it should be cheaper to build, in a shop properly equipped, than the ordinary firebox. Riveting is substituted for staybolting and the difference should more than offset the cost of the formed channels and stayplates of which the sides and crown are built up.

As for the important question of safety, so far as can now be seen, the construction appears to have a much larger margin of strength than the staybolted boiler. The diaphragm stayplates are much stronger than staybolts, and are secured at their edges by a riveted joint far stronger than that afforded by the hold of threaded staybolts in the side sheet. What stresses may be produced by uneven heating can hardly be certainly prophesied until the construction has had long trial in service. Certainly, however, so far as "fore and aft" stresses are concerned, the construction provides for them in a remarkable manner.

It remains for some ingenious designer to work out some plan of eliminating also the staybolts at the fire door end of the locomotive firebox.

Altogether this new system seems entitled to rank as among the most important improvements in locomotive design that have been made in a quarter century. Railway officers will do well to keep close watch of its record in actual service.

LETTERS TO THE EDITOR.

Should Not the Railway Resident Engineer Pick His Own Men?

Sir: In a lecture of Mr. Herbert F. Stimpson before the senior class in mechanical engineering at Columbia University there was some description of the qualifications of the General Manager which seem to me to be applicable to the railway civil engineering departments as I have found them.

Mr. Simpson said:

The old theory as to the General Manager was that he should possess a universal knowledge of everything connected with the business and should be able to decide immediately as to the most minute detail, a thing which we now see to be impossible. The new theory is that the General Manager should have the ability to surround himself permanently or temporarily with a body of men each of whom is an expert in his own line, and to focus the united ability of these men or so many of them as may be required upon any item which may arise. Each of these men in turn surrounds himself with others who in turn handle smaller subdivisions of the problem.

My railway experience has been on three roads under five different Chief Engineers and their organizations, and entirely in the field. In every case the personnel of the parties above axeman was determined at the General Offices. A very important locating party had a draftsman sent to it who a few years before had been fired by the Engineer-in-Charge for incompetence. A topographer and a rodman on this same party tied things up for two weeks through slack work. Another locating party on another road had on it the nephew of a member of the Board, a nephew of the Vice-President, a son of the Superintendent of Transportation, a son of a conductor, and two or three others picked out at the General Offices on account of personal relations. None of these men had had previous experience, and five years afterwards only two of them were on engineering work of any kind and they had become instrumentmen.

On construction the same conditions existed, and the only way that satisfactory results could be obtained was by starting men as axemen, and gradually getting them where they were needed. I have had a $35 axeman inspecting masonry while the $90 masonry inspector worked inefficiently as axeman.

Of course when the Engineer-in-Charge asks the General Offices for a man or men of certain qualifications the case is entirely different.

How can a Locating or Resident Engineer get economical results or fill his position unless he in the main selects his own party, or again how can he expect to compete with the man who does select his own party?

For my own case, should conditions be such that I return to railroad construction, it will be distinctly understood that I select my own party, or I will look for a place on the grade.

Respectfully,

Ex-Resident Engineer.

Lexington, Va., June 3, 1909.

"Improvement in the Economic Status of the Engineer."

Sir: We desire to express our appreciation of the freedom with which you have opened your columns to the discussion of the economic and ethical status of the engineering profession. Your editorial remarks of May 20 indicate that you do not take issue with those who hold that considerable improvement in the economic status of the engineer is not only desirable but necessary. We assume that you intended only to express your disapproval of any "organized" effort to better the present unsatisfactory conditions. Apparently your criticism of "union methods" was aimed more particularly at the Technical League and its activities.

We regret the fact that your misunderstanding of the true purpose of the Technical League has led you to make the statements you made. They undoubtedly have created an incorrect impression in the minds of many who have read them. We feel constrained under the circumstances to request permission to attempt to correct that impression, at the same time expressing the hope that you will keep your columns open to a further free expression on the important questions of ethics and compensation in the profession.

That the "Labor Union Idea," as you term it, is not the fundamental idea of the league, that it has higher purposes in view than any union ever possessed, that it is not trying to rally to its support only the discontented and disgruntled members of the profession, but that it is trying to advance the technical man in every possible way and is advocating a cause that will meet with the hearty approbation and support of every earnest minded, ambitious engineer who has the best interests of his profession in mind, may be best shown by a statement of its objects. These, in brief, are as follows:

To protect the engineer's interests in all ways and particularly by making engineering a closed profession. To increase his compensation along legitimate lines by bringing to public notice the value of his services. To inculcate professional ethics. To dignify his profession. To promote an esprit de corps.

What is there in these fundamental principles that can be condemned?

The members of the League feel that the modern method of organization in the furtherance of these objects is immensely superior in the accomplishment of results when compared with the individual effort urged by some of your readers. Knowing that the desire and need for improvement is greater in the lower ranks of the profession, the League has, for the present, limited its activities to the "employed" engineers, endeavoring to bring them to a fuller realization of the dignity and nobility of their profession and of their worth to the community. The membership, for a time at least, has been made secret merely to protect the younger members and is necessitated by the deplorably commercialized condition of the entire profession.

It is hardly necessary for us to state that we recognize with you and with others in all ranks of the profession, that in the very nature of the engineer's work, lies the impossibility of "establishing a level above which few rise and below which none are allowed to sink." Engineers are not engaged in an occupation whose output can be either measured or limited. No union, bound by whatsoever oaths or laws human ingenuity could perfect, could ever be able to control a following covering so wide a field of human endeavor as this, nor could it limit the varied product of the brains of its members to one dead level of accomplishment. No such attempt is being made. The effort would be too great, the result too apparent in its futility.

The Technical League apparently is at fault because it has endeavored to emphasize and bring home to the profession that a full recognition of the debt of the community to the profession, both by the public and by the engineers themselves, must eventually compel a remuneration, in the lower as well as in the higher ranks, more commensurate with the immense responsibilities which the engineer carries. This debt is not now recognized, except perhaps in a few laudatory public remarks here and there. An effective organization is needed to bring to the engineer his deserved share in the prosperity of this great country, in the development of whose resources he has been a most important factor. The community at large is but little to blame for existing conditions in the profession. It does not even know how poorly the profession is paid, and what small regard employers have for their engineer's professional dignity and for the responsibilities which he is compelled to assume in the exercise of his duties. To what state of unrest would the public mind be raised if it were generally known that the great bridges, dams, tunnels, railroads, office buildings and other magnificent products of this great age of construction were being thought out, designed and constructed by a body of usually overworked and nearly always underpaid men? Does the public know that in most engineering offices calm thought and patient investigation is impossible; and that the undignified and otherwise unjustifiable "crowding of work" compels men to undertake unreasonable responsibilities, with small opportunity to properly fulfill the duties which these responsibilities impose.

A great structure recently collapsed. An investigation brought out the fact that the fee paid to the engineer upon whose decision the safety of the structure depended, was so small that he could not engage a force sufficiently large to make the proper investigations, nor even devote his own time properly to it. The smallness of the fee is a matter to be regretted; but more regretable still is the state of the ethics of a profession which permits a prominent engineer to undertake such responsibilities under such conditions.

Innumerable instances might be cited showing that the same state of affairs prevails. There are a few men who, by serving on several commissions and by accepting a sufficient number of calls in a consulting capacity have brought themselves into public notice because their yearly incomes approach that of a second-class lawyer or a first-class jockey. But these men have had to slip over things, to let things pass that should have taken weeks of careful investigation, to give but a cursory examination to the manifold affairs brought before them, in other words "have spread themselves out too thin." These are the generals of the profession. The editor of Engineering News can probably cite twenty men in the profession to whom this would apply. The privates do not come under his observation; but we can assure him that their plight is similar. The field they cover is not as great but they too are stressed dangerously near the breaking point.

Other professions through their organizations compel recognition at the hands of the public and see to it that they are properly protected in their rights in the community and against the imposter and the unskilled in their own ranks. In this respect the Technical League has a purpose akin to the Medical and Bar Associations.

The Technical League, however, must and does go further than these associations. The lawyer and the physician exacts his fee directly from the public. The engineer, rendering equally important service to the community, receives his fee, with few exceptions, from an employer, in the shape of a salary. The latter finds it difficult to realize that the enhanced efficiency of well paid engineers would be greatly to his own advantage and to that of the public whom he serves. The members of the League have come to realize that to compel a proper recognition of the profession, both in the matter of remuneration and of standing in the community, systematic effort on the part of the engineers themselves and a strong public opinion, based upon a better understanding of the engineer's work are necessary. With this in view the League is perfecting its organization, asking the support of the profession at large and hoping that, through a more complete understanding of our aims, your opposition will change to active support.

Respectfully yours,
The Executive Committee of the Technical League.
721 Park Row Bldg., New York City, June 9, 1909.

A Neglected Safeguarding of the Public Interest In Water-Power Rights by the American States.

Sir: I have been much interested in reading the discussions in the American magazines and newspapers which reach me, of the public's rights in water powers and the need to take adequate steps to protect them. This is of especial importance to the states traversed by the great mountain ranges of the West. Here the water which fills the streams falls largely on public land and is in the fullest sense public property. If conserved in the public interests it would be possible, either through municipal effort or through the leasing of power privilges, for the Western cities and communities to have light for homes and power for small manufacturing industries at such low prices as to render the conditions of life there more attractive and to greatly promote settlement and development. The states could also, under an enlightened policy of this character, secure to future generations all the opportunities that are now enjoyed and develop and control these resources for the common good. Instead of doing this, however, they are, through indifference and neglect, permitting them to be transferred perpetually to private and selfish interests.

It is well known throughout the West that all the great railway corporations are actively at work securing control of power sites along their lines and that syndicates, having their headquarters in New York City, are acquiring a monopoly of the valuable power privileges which are not absorbed by the railways. The result in a few years will be that the people of these states will derive no more benefit from these natural resources which they are now giving away, than if these snow-crowned summits were on the other side of the world. The prices for power and the prices for light will be made just as high as the traffic will bear and the revenues from melting snows will go to the predatory New York stock jobber.

To those who have a pride in their country and who like to believe in its capacity for self-government, it is most irritating to see how poorly the people of the United States are dealing with economic questions as compared with the rest of the world. Take the management of streams as an illustration. Heedless of the constantly increasing importance of water and the necessity for an evolution in the water law to conform to its changing industrial status, we still adhere unthinkingly to the English Common Law doctrine of riparian rights, although it has been abrogated in both Canada and Australia, two British colonies having far less at stake than the United States. Under the riparian doctrines all that is needed to acquire control of water power is to acquire a few acres of land abutting the two sides of the stream. One needs only to consider the magnitude of the interests involved to realize that the ownership of power privileges ought not to be disposed of in that fashion. That there is a much more enlightened method of promoting public interests in streams is shown by the legislation of some of the Australian states. In Victoria, for example, the state retains ownership of the land bordering the stream. It is, therefore, the sole riparian proprietor, and can determine how the water is used and who shall have access to the water frontages. When the American public stocks a stream with trout, only the r[illegible]ian landowner gets the benefit, because he controls th[illegible]shing ground. when the State of Victoria stocks a [illegible]m the public get the benefit. The landowner's ex[illegible]ve privileges stop 1 chain (66 ft.) from the bank. *[illegible]as to fish of the same log as his hired man.* [illegible]ustralia the declaration that the water of natural s[illegible]ms is a public property means all it says. In the [illegible] of Victoria, for instance, all rights for diverting [illegible]er, whether for power or irrigation purposes, are lim[illegible] to 15 years, and all those who divert and use wate[illegible]y a nominal fee for the privilege. In arid America it [illegible] the universal practice to make grants in perpetuity wi[illegible] any charge for the water used, but the burden and [illegible]nse of regulating these rights falls on the general [illegible]ayer.

We have been a blindly improvident [illegible]ation in the management of our great natural resou[illegible]. Both the rights of future generations, and much [illegible] of the public good in this, are being sacrificed becau[illegible] of it. When is there to be an awakening?

Sincerely your[illegible]
Edward Mead, M. Am. Soc. C. E.
Melbourne, Victoria, Australia, May 6, 1909.

[Many but not all our readers are aware that Mr. Mead speaks with the authority of one who was for a number of years Chief of Irrigation Investigations, U. S. Department of Agriculture, and before that State Engineer of Wyoming. He is now serving as Chairman of the State Rivers and Water Supply Commission of Victoria.—Ed.]

Annual Convention of the American Water-Works Association.

The 29th annual meeting of the American Water-Works Association was held at Milwaukee, Wis., on June 7 to 12, covering practically an entire week, although few members were in attendance for the entire period. There were 11 sessions in all. On Monday, June 7, there was the formal opening meeting, with the address of the President. On Wednesday afternoon there was a visit to the works of the Allis-Chalmers Co. and the Prescott Pump Co., followed by a dinner. On Friday there was an excursion to Whitefish Bay. There was a good display of water-works materials and supplies. The program was very long. Most of the papers were presented, but only a few were read in full. Over 200 members registered, and the total attendance (including visitors and the water-works supply manufacturers' organization) was over 500.

The address of the President, Mr. D. W. French (Weehawken, N. J.) referred to the encouraging development in the filtration of public water-supplies, and pointed out that it is better to undertake this voluntarily before trouble occurs than to be forced into it by an epidemic of typhoid fever.

In the following report of the proceedings we have grouped or classified the papers in regard to subject matter, and without regard to the order of their presentation.

Water-Works Regulation and Valuation.

A paper on "The Wisconsin Public Utility Law" was read by Mr. C. B. Salmon (Beloit, Wis.), and called forth considerable discussion in the way of enquiries for additional information as to the details of the law and its application. Information regarding this law, which puts the regulation of public utilities under the control of a commission which is proceeding to make valuations of all these utilities, has already been published in Engineering News. It is notable that the law is accepted and concurred in by those responsible for the various utilities, and that the just and impartial attitude of the commission is universally recognized. Mr. Salmon thought that the commission would eventually put every water-works on a meter basis.

In Mr. Salmon's paper and in the discussion of it reference was made to the "going value" of water-works plants, and Mr. John W. Alvord (Chicago) followed with a paper presenting his views on "Going Value and the Methods for its Computation." The theory of valuation in accordance with reproduction costs is very complex; so much so that in Mr. Alvord's opinion courts and appraisers might find it advantageous to ascertain the past actual honest investment in any given plant and property, regardless

of its appreciation or depreciation. He suggested also that where the municipality holds an option to purchase a plant at an appraised valuation after certain periods of time, the value of this option might be recognized in some way in the valuation.

This paper attracted more attention and called forth more serious discussion than any other paper on the program. The discussion turned largely on the last-named suggestion as to an allowance for the value of an option of purchase. Mr. D. W. Mead (Madison, Wis.) remarked that there are costs of administration and development, as well as of construction, although they are not so obvious as this last. The "going value" is established at considerable expense, and is as equitable a charge as that for any feature of construction. It is difficult to establish its exact value in any one case. It cannot be determined by mathematical formulas, but must be left to justice and fair judgment. As to the option of purchase, he did not think a municipality was entitled to have any allowance for this in the valuation for purchase. Many water-works plants have made no return to those who invested money in them (as they have to continually develop and enlarge them) when depreciation, interest and operation are taken into account. The valuation for the purchase under option should include every dollar honestly put into the plant. Mr. D. H. Maury (Peoria) took the same view, and held that the option is simply one of the provisions of the contract, and should not be considered as affecting the valuation of the plant. It might be regarded as the difference between a fair valuation for the property and the valuation which the company might make to "hold up" the municipality if it desired to purchase but had no option of purchase under the franchise.

Mr. Alvord, in reply, remarked that the option clause has a value, as by it the city's foresight has reserved to itself a valuable right which may be of great importance in some cases. Mr. L. Metcalf (Boston) agreed with Mr. Alvord, while Mr. Reimer (East Orange) took the opposite view.

The question of valuation was presented also in a paper by Mr. L. L. Tribus on "The Acquisition of New York City of Two Water Supply Systems on Staten Island." A valuation of $862,273 was made by an engineering commission, and then $907,000 by an arbitration board of engineers. The award included $70,000 for going value. The board did not agree as to the water rights, which were variously estimated at $300,000 to $570,000. The company finally accepted $1,100,000 rather than have its mains paralleled. Mr. Tribus said:

> In this figure the company received fair treatment. It had earned enough in its nearly 30 years of operation to have paid its investors handsomely had there not been waste in construction and operation. Even with that, however, the sum awarded represents fairly a return of the invested capital and reasonable profit upon it.

Mr. James R. Fitzpatrick, in a paper on "An Attempt to Annul a Perpetual Charter," described the controversy between the city of Grand Rapids, Mich., and the Grand Rapids Hydraulic Co. The latter was granted a charter by the state in 1849, and the city installed a municipal plant in 1870, but the city supply was taken from Grand River and was of inferior quality to that supplied by the company. After numerous attempts to induce the company to sell out, the city applied to the legislature to repeal the charter. A bill to this effect was passed in two days, without notice being given to the public. The company is still fighting for its rights and has carried the case from court to court. A final decision is expected next year.

Water Purification and Softening.

Three papers were read dealing with the so-called "sterilization" of water at the Boonton reservoir of the Jersey City Water Supply Co. The process is really one of disinfection and consists in the addition of a solution of bleaching powder, or "a mixed salt of" about equal parts of "chloride of calcium and hypochlorite of calcium" or lime, the latter being the active agent through a process of oxidation. Dr. J. L. Leal outlined the process and the conditions which led to its adoption in this case. Mr. Geo. W. Fuller described the construction and operation of the plant, and Mr. George A. Johnson dealt with the analyses of the raw and treated water and the cost of treatment. We shall give abstracts of these papers in a later issue.

In the discussion, Dr. W. P. Mason (Rensselaer Polytechnic Institute) said that while he had been skeptical as to this process, he had been converted by the results of his own experiments. As to the possibility of the consumer taking chlorine into his system with the treated water, he thought this very remote. Even admitting that they did so, the dose would be so infinitesimal that it would have much less effect than many matters that are taken into the stomach in connection with food and drink. Mr. Carl Herring referred to the process as a possible adjunct of filtration, and Dr. Bartow spoke of tests made by him with "bleach" at Lake Forest, Ill., and at the University of Illinois. The use of copper sulphate for water purification was also mentioned. Mr. Johnson and others referred to the plant built by the Union Stock Yards Co. at Chicago for treating sewage-laden water, and which produces a water superior to the raw water supplied by the city. Mr. N. S. Hill, Jr. (New York), said that the "bleach" process had been considered by the experts engaged in behalf of Jersey City, but was not approved by them.

A paper by Mr. A. E. Walden described the results obtained by the application of hypochlorite of lime (or "bleach") on mechanical and slow-sand filters at Baltimore. It reduces the amount of coagulant used, and also the amount of wash water for cleaning the beds. A paper by Mr. S. T. Powell described a chemical and bacteriological laboratory equipped with electrical regulating devices. These have been found very satisfactory. The operation of the filter plant (Eng. News, March 18, 1909) is all done electrically and is controlled by switches in the laboratory.

Three papers were presented dealing with water-softening and the treatment of boiler water. One by Mr. M. Miller outlined the economic results of chemical treatment, and described different processes. Mechanical treatment (by feed-water heaters, blow-off cocks, etc.) has but a limited effect. The cost of water-softening plants ranges from $4 or $5 per HP. for plants up to 1,000 HP., to $1.20 or $2 per HP. for those of 5,000 to 15,000 HP. A paper by Mr. W. M. Booth was of a similar character. The third paper, by Dr. E. Bartow (University of Illinois) included a table showing the hardness of the water-supply of 98 Illinois towns, with the amount of lime and soda-ash required for softening in each case.

The unsanitary conditions of the southern end of Lake Michigan as a source of water-supply, due to pollution of sewage and industrial wastes, was described in a paper by Mr. J. H. Brewster. These conditions have been described in papers before other societies, and have been noted in our columns. The plant for the removal of iron from the water-supply at Superior, Wis., was noted by Mr. W. C. Lounsbury in a paper dealing with the development of the water-supply of that city. A peculiar feature of the supply system is a series of 6-in. wells along the sandy shore of Minnesota Point, each well having near the top a connection to an inclined well which extends under the bed of the lake.

Uniform Annual Accounts and Reports.

The Committee on Uniform Annual Accounts made only a brief verbal report, but stated that two papers on the subject had been prepared. The one by Mr. Albert H. Wehr, discussed "Uniformity in the Accounts, Financial Reports and Statistics of Water-Works." It pointed out that with the increase in number, size and importance of all classes of public service, uniformity in accounting methods becomes necessary, in order to secure comparable financial and physical statistics. The problem has been forced upon public utilities in one way or another by state and federal regulation, but the water-supply enterprise has been one of the last to undertake its solution. This is due to the lack of any uniformity in the conditions under which water-works as a class are operated, and the consequent difficulty of devising a general scheme comprehensive enough to meet the varying conditions and yet flexible and simple enough to make it easily applicable in all cases. The first work of a definite character was undertaken by the U. S. Census Bureau, and credit was given to Mr. L. Powers, Chief Statistician of the Bureau, for the classification of accounts allowed in the report on statistics of cities having a population of over 30,000 for 1906. Credit was also given to Mr. M. N. Baker (Editor of Engineering News) for his contributions on the same subject, published in the appendix to the above-named report.

Mr. Wehr's paper presented a system of classification of accounts based upon the work of Mr. Powers and Mr. Baker, but with some modifications. As a preliminary to a schedule of accounts the paper gave an analysis of the several accounts and items to be included. The paper was not read. Nor did Dr. Powers read his paper on the same subject, but he made a brief statement as to the necessity and advantages of uniform accounting, with a strong recommendation for the system proposed by Mr. Wehr. At first sight, he stated, the system looks so intricate and cumbersome that it might be thought impracticable. It is really simple, however; it is both comprehensive and flexible, and can be applied to large or small enterprises with equal facility. Water-works and other enterprises must be operated intelligently if they are to be successful, and they cannot be run intelligently without a proper system of accounting. He thought that every water-works official should give careful study to Mr. Wehr's system, and not condemn it simply for the reason of its apparently formidable difference.

There was practically no discussion on the two accounting papers, but Mr. D. R. Gwinn (Terre Haute) considered that the introduction of the proposed system would produce very valuable results in a few years. Up to the present time very little headway has been made in this direction, but definite steps should be taken without further delay.

Fire Protection and Insurance.

A brief verbal report for the Committee on Fire Protection was made by the chairman, Mr. Charles A. Hague (New York). He suggested the general advisability of reinforcing the distribution system in order to ensure better fire protection. If such a step is recommended to the city authorities simply as an improvement it stands but a poor chance of adoption. But the commercial side of the improvement, as related to consequent reduction in insurance rates, is very important and if presented to the authorities would probably have considerable weight with them.

This precipitated a somewhat warm discussion as to the water-works and insurance aspects of fire protection. Some members remarked that when improvements had been made in accordance with the suggestions of the underwriters, the insurance companies failed to make reductions in rates. Other members had had satisfactory experience with the schedule system, a definite schedule of improvements being prepared and a certain reduction in rates allowed for each of these as completed. Mr. F. M. Griswold (New York), representing the National Fire Protection Association remarked that of the enormous annual financial loss only 40% is covered by insurance, and he thought that municipalities should furnish an adequate water-supply for fire protection without regarding insurance rates as a basis for improvements to the water system. He thought that municipalities were under a "moral responsibility," as public utilities, to furnish a sufficient supply of water for fire protection. Insurance companies, being purely business concerns and not public utilities, have no such responsibility in the matter.

Mr. D. H. Maury (Peoria) combated this view very forcibly, urging that it is a matter of business for both the water-works and the insurance companies, and that there is no question of "moral responsibility" involved. The matter was

also discussed in a paper by Mr. C. H. MacFarland on "The Liability of Water Companies for Fire Losses," who referred to several suits in the courts. He said in part:

> Only three states have gone so far as to hold water companies liable to individuals and taxpayers under a contract made with the city for the purpose of furnishing water for fire protection.
>
> As a matter of public policy it would seem that these courts have erred. Corporations organized for the purpose of supplying water must necessarily perform the service at a reasonable rate, and if water companies are to become insurers of property the rate of returns must be such that no community would tolerate them. Even if the city would consent to such a remuneration for hydrant rental as to enable the water company, under ordinary circumstances, to protect itself against losses, yet a conflagration might at any time occur of such magnitude as to bankrupt the company, and thereby disable it so far that it would be unable to protect the very citizens who had been taxed for such an emergency.
>
> If water companies were to be held liable for fire losses then they must necessarily provide a large reserve fund from year to year to meet any and all emergencies. In other words, they become insurers against loss due to any lack of pressure or supply in case of fire. The water company would be placed in a rather peculiar position. The water is to be furnished to the fire department of the city, and they are to apply the water, not the water-works company. Who can say that the water was not supplied in proper quantity and with proper pressure, and that the failure to put out the fire was not due to some neglect or failure on the part of the fire companies.

An illustrated address on "Fire Wastes" was given by Mr. Herbert M. Wilson (U. S. Geological Survey). In 1907, the total fire loss of the country was over $456,485,000, while the loss due to the buildings and their contents was $215,000,000, or $2.51 per capita as against 33 cts. for the six leading nations of Europe. The total cost of the water-works of this country in 1907 was $1,129,247,532, of which 78% was chargeable to domestic service and 22% to fire service. It has been assumed very often that the additional cost of water-supply on account of fire protection may run as high as 40 to 60%, but his investigations show an average of 22%. The total annual expense due to fire service is about $28,856,235. In this connection he gave the following per capita cost of water-works systems, classed by population and by geographical districts:

Population.	Cost per capita.	District.	Cost per capita.
100,000 and over....	$32.72	New England.....	$32.19
30,000 to 100,000.....	29.06	Central	20.35
5,000 to 30,000.....	23.60	So. and So. East....	19.34
Under 5,000.....	16.59	Rocky Mts. & West..	63.77
		Pacific	28.96

Fuel and Boilers.

Three groups of papers related to questions of fuel, boiler plants and boiler water for pumping stations. The last have been mentioned under the heading of Water Purification.

The purchase of fuel on the basis of its heat value was dealt with in two papers. Prof. E. W. Bemis described the system under which both coal and oil fuel are purchased for the Cleveland water-works; the former by its B. T. U. contents and the latter by the gallons of water pumped per gallon of oil. Mr. E. H. Taylor (Chicago) described the system used by him in the purchase of over a million tons of coal, and which has been adopted by several large consumers. Under this system, a B. T. U. determination is made for each contract, and the contractor gets a penalty or a bonus according as the coal furnished varies above or below the B. T. U. value. He discussed also the forms of contract used in the purchase of coal by several municipalities and large private consumers. This system of purchasing coal by its heat value has been dealt with in our columns, and space does not permit of its further treatment here.

In the discussion, Mr. W. S. Cramer (Lexington, Ky.) thought in too many cases more weight was given to laboratory analysis than to methods of combustion. It is one thing to get coal with a high value in B. T. U. and quite another thing to utilize this value, and he considered better results would be obtained by studying the furnace plant and methods. With coals of over 13,500 B. T. U. he had found it impracticable to obtain the excess value. One member advocated evaporation tests, but Mr. Cramer and Mr. Taylor considered them unreliable, besides being too costly and laborious for use in ordinary plants. One member remarked that an investigation as to heat value had shown a local coal to be really more economical than a coal which had been obtained from a distance on account of its supposed superiority.

Papers by Mr. Herbert M. Wilson on "The Use and Abuse of Fuels" and Mr. D. T. Randall on "Coal for Hand-Fired Plants" related to the investigations of the U. S. Geological Survey. A paper by Prof. S. E. Parr (University of Illinois) on "Chemical Data as Related to Boiler Plants," discussed the proper methods and practical utility of coal analyses.

A paper on "Smoke and Smoke Prevention," by Prof. L. P. Breckenridge and K. G. Smith, related to the well-known work of the engineering experiment station of the University of Illinois. The smoke question was mentioned also in a paper by Mr. John W. Hill on "Modern Boiler Practice." He thought that the smoke evil might be mitigated or avoided by forced draft, automatic stokers and the proper proportioning of the boiler and furnace to their work. A paper by Mr. J. M. Whitham suggested that the economic relation of the fireman to pumping station efficiency is not sufficiently recognized, as "the fireman by inattention can waste more coal in a day than the engineman can waste in a week." Mr. J. M. Diven instanced a case where a night fireman (with the plant partly shut down) used as much coal as the day fireman.

The boiler equipment and operation at the water-works pumping station of Harrisburg, Pa., was described in a paper by Mr. Geo. J. Kennedy. A peculiar feature of the plant is that the fuel is waste anthracite of buckwheat size, washed down from old culm banks and dredged from the Susquehanna River at the pumping station by a pump. It costs from $1 to $1.25 per ton, and averages a heat value of 13,000 B. T. U. This coal averages 79.7% fixed carbon, 13.60% ash and 6.12% volatile matter. For hand firing it must be mixed with bituminous coal, but at this plant it is successfully burned by the use of automatic stokers. For three months of 1909, there were 870,933,300 gals. of water pumped (against an elevation of 235 ft.) at a cost of $1.56 per 1,000,000 gals. for coal and $3.66 for coal, oil, waste and labor. Mr. S. Bent Russell (St. Louis) presented a short paper on "Practical Considerations in the Handling of Coal at Pumping Stations."

Pumping Engine Performance.

A paper on "Milwaukee Pumping Engines," by Mr. Cornelius T. Meyers, described the equipment of the North Point pumping station from 1874 to the present time, and gave the results of tests and regular service performance. The station duty of two triple-expansion 20,000,000-gal. engines in 1908, for a continuous run of 168 hours (pumping at varying rates) was 129,490,653 ft.-lbs. per 100 lbs of coal (without allowing for the coal chargeable to the small engines), and 160,097,000 ft.-lbs. per 1,000 lbs. of dry steam. The results were within 2¾% of the duty developed on the trial test, and within 1½% of the guaranteed test duty. He did not think such results had been approached elsewhere. Mr. Geo. H. Benzenberg, M. Am. Soc. C. E., commented upon the remarkably good service performance as an instance of what could be done with engines properly handled by competent men who are retained in their positions because of their competency.

Two papers dealt with the question of superheated steam. One by Mr. E. H. Foster on "Superheating for Duty" referred to the special advantages for pumping stations, where the engines are run steadily and continuously. He stated that since 1901 at least 27 pumping stations in leading American cities have adopted its use. A paper by Mr. John Primrose reviewed the official tests of the four 30,000,000-gal. pumping engines for the Cincinnati water-works. The steam and coal consumption when using saturated steam was remarkably good; 1.160 and 1.168 lbs. of coal, and 10.72 and 10.85 lbs. of steam, per Ind. HP. per hour. But when using superheated steam there was a saving of 6.8% in coal and 12.6% in steam. He stated that:

> The use of superheated steam in this instance has resulted in a performance which has never been equalled in this country.

Asphalt Coatings for Cast-Iron Pipe.

The Committee on Water-Works Standards made a report on this subject in accordance with a resolution adopted at the 1908 meeting. The chief features desired in a [illegible] coating are: (1) perfect and permanent adhesion to the metal; (2) resistance to the corrosive effects of water, acids, electricity, etc.; (3) a smooth finish, especially on the interior surface. The committee believes that there are commercial possibilities for an improvement on the ordinary coal-tar pitch coating, and points out that a higher cost is not objectionable if the results warrant it. No practical tests have been made by the committee, but it believes that:

> Asphaltic coatings will cover better and cling closer and more tenaciously than coal-tar pitch. Asphaltic materials will resist the elements for at least as large a period as any other for the same purpose, and very likely for a much larger period than any other.

The committee recommended that there should be added to the association's specifications for cast-iron pipe a paragraph on asphaltic coating that may be used as an alternative for the present paragraph on coal-tar pitch coating. Unfortunately, the committee specified that the quality of the coating must be equal to that of a certain trade material. This action was strongly objected to in the discussion, as advertising the maker of one particular coating when there are other makers of similar materials. The committee somewhat resented this objection, but it was voted to eliminate the objectionable reference.

Municipal Ownership.

The municipal ownership of public utilities was advocated in a paper by Mr. A. Maclean on "Municipal Ownership in Edmonton, Canada." He outlined a series of municipal enterprises in that city, the authorities being of opinion that anything in the nature of a monopoly could best be administered by the city. There is a board of three members: the mayor, finance commissioner and public-works commissioner. The author considered that the city has under this system financed and carried out works with a degree of success to private enterprise. He stated his belief

> that the greatest controlling factor in the success of municipal management in Edmonton is the fact that the heads of departments have been given complete control of their respective spheres, with a tacit understanding that they have been placed there to "make good" or get out. Not merely is the mechanical operation of each department completely under the control of the superintendent, but he also is responsible for all the financial details involved in its operation, both of revenue and expenditure. This entirely precludes the interference from which expert city officials sometimes suffer.
>
> It is hardly to be wondered at, that Edmonton should forge ahead on its progressive course, and that with a street railway system which would do credit to a city twice its size and 50 times its age; a telephone system of the latest Strowger automatic electric type; a power and light system growing fast, but scarcely fast enough to accommodate users on account of its exceedingly low rates; an extensive water-works system gradually being evolved and expanded to meet the demands made upon it by its growing population; Alberta's capital should lead the way to a condition of municipal life in which all the cities of North America should control their own franchises and utilities and dispense with all the scandal and suspicion of graft, which connects itself with their sale.

In the discussion, one member suggested that municipal management is free from the attacks by adverse legislation to which companies are often subject. Mr. John W. Alvord expressed the view that rotation in office is one of the causes of uneconomical management of municipal departments. Under such a system, a man who has mastered the affairs goes out of office, and the new man cannot understand the proper management, however enthusiastic and well meaning he may be.

Typhoid Epidemics.

A paper on "A Typhoid Epidemic Due to Milk" was read by Prof. Erastus Smith, of Beloit, Wis., relating to the experience of that city in 1906. Investigation showed that the water-supply could not be responsible, and the enquiry narrowed down to the milk supply. It was found that a certain farm supplied the families where cases had developed, but the sanitary conditions at this farm were exceptionally good. Further enquiry showed that the farmer purchased some cans of milk to complete his supply, and the infection evidently came from one of these. In the discussion, Mr. A. H. Wehr (Baltimore)

referred to the great danger from patients when convalescent, and even for as long a time as two years.

Another member cited an instance where a single case of fever on a drainage area of a reservoir started an epidemic. Shutting off this water did not stop the spread of the disease. Investigation showed that foreign laborers recovering from slight attacks of typhoid frequented the saloons, and the infection was spread by the common use of drinking glasses.

Mr. N. S. Hill, Jr. (New York), referred to curves showing the increase of typhoid fever cases in New York in the fly season. Dr. Smith pointed out that in most typhoid fever epidemics the water-supply is the first thing held responsible by the public, so that water-works managers are directly interested in the investigation of the actual causes.

Water-Waste Surveys.

A paper on "Water-Waste Surveys in Chicago," by Mr. T. C. Phillips, described the investigations made by the city with a view to checking the very high rate of consumption, which amounted to 240 gals. per capita per day in 1907. The work was begun in the business district in order to avoid the necessity of laying larger mains at this time, as the streets may be opened up for a street-railway subway in a few years. The waste is mainly by small leaks in the plumbing. Mr. Reimer (East Orange, N. J.) said that a night consumption of 64% of the day consumption in a wealthy residence district led to a pitometer survey being made, and the defective plumbing fixtures and conditions in houses of this class was very surprising. In 1908, it was estimated that 50% of the water pumped was lost; this was very serious, as the supply was drawn from wells. As a result of house-to-house inspection, the per capita consumption was reduced from 130 to 85 gals. per day, and is now about 95 gals.

Miscellaneous.

In a paper on "A Producer Gas Pumping Plant," Mr. J. R. Fitzpatrick gave particulars of tests of a plant for the Grand Rapids Hydraulic Co. A paper by Mr. H. C. Heermans described the methods taken by the water company at Hoquiam, Wash., to educate the public in the avoidance of water waste. Circulars were distributed among the consumers for this purpose. A paper by Mr. W. Volkhardt discussed the basis of making meter rates. Mr. Wm. C. Mabee, in a paper on "Concrete in Water-Works Construction" referred generally to the wide use of concrete and particularly to the concrete structures of the Indianapolis Water Co. (Eng. News, April 26, 1906, and Oct. 15, 1908). These include an aqueduct with four 60-ft. arches, filter bed roofs, a venturi meter (with brass lining), conduits, basins, etc. A paper by Mr. Robert E. Horton dealt with the valuation of water power and the estimation of damages from stream diversion.

None of the committees presented reports of importance, and one committee having failed to do any work was discharged at its own request. For the Committee on Electrolysis, Mr. D. H. Maury (Peoria, Ill.), presented a brief progress report. For the Committee on Depreciation, Mr. J. W. Alvord (Chicago), presented a similar report as to the investigation to determine the average life of machinery, and apparatus. Other questions to be considered are (1) what matters should be classed under maintenance and depreciation, respectively, and (2) whether a sinking fund should be established. The Committee on Water-Works Standards reported on pipe coatings (as noted above), and also recommended the use of the design and metal for hose couplings as adopted by the National Fire Protection Association. These couplings were exhibited and explained by Mr. F. M. Griswold. The report of the Committee on Publications, presented by Mr. D. H. Maury, recommended that for future meetings the papers should not exceed 6,000 words in length. Dr. W. P. Mason (Troy, N. Y.), Chairman of the Committee on Water Supply Investigation, asked that this committee be discharged; it has done no work on account of the great scope of the subject and the fact that the subject is already being investigated by the government.

The report of the Committee on Reorganization had been looked for with some interest, but the committee merely submitted a brief statement to the effect that it had made some inquiries as to the establishment of permanent headquarters. The committee was continued.

Officers.

The election of officers resulted as follows: President, Dr. W. P. Mason (Rensselaer Polytechnic Institute), Troy, N. Y. Vice-Presidents, John W. Alvord, Chicago; Alexander Milne, St. Catherine's, Ont.; D. R. Gwinn, Terre Haute, Ind.; Robert T. Thomas, Lowell, Mass.; John A. Affleck, Harrisburg, Pa. Secretary and Treasurer, John M. Diven, Charleston, S. C. The next meeting will be held at New Orleans, La., in 1910.

Further Reports Upon the Blackwell's Island (Queensboro) Bridge Over the East River.

The design of the Blackwell's Island Bridge (now called the Queensboro Bridge) over the East River at New York City, is again brought to the attention of the profession by further reports upon it, which have just been made public by the Pennsylvania Steel Co., of Steelton, Pa., contractor for the fabrication and erection of the superstructure.

Our readers will remember that the public agitation last summer for an investigation of the bridge resulted in expert reports by Boller & Hodge and Prof. W. H. Burr (Eng. News, Nov. 12 and 19, 1908), whose effect, broadly speaking, was to show that the bridge (1) weighs more than was assumed in its design, and (2) has a much lower live-load capacity than it should have. Both experts, however, praised the workmanship of the structure, so that the contractor was not involved in the criticisms.

It happens, however, that Mr. F. C. Kunz, Chief Engineer of the Pennsylvania Steel Co., was formerly in the New York Bridge Department under the administration of Mr. Gustav Lindenthal, and had more or less to do with the early work on the design of the structure. Further, while the contracting firm was in no way responsible for the design of the structure, its engineering staff necessarily had to become familiar with the design.

Under these circumstances, therefore, Mr. J. V. W. Reynders, M. Am. Soc. C. E., Vice-President of the Pennsylvania Steel Co., requested Mr. Kunz to prepare a report upon the bridge, "setting forth all the salient points that have been raised from time to time, with such information as we are able to supply in regard to the same."

This report, dated Nov. 27, 1908, was then placed before four engineers: Charles MacDonald (Past-president Am. Soc. C. E.), C. C. Schneider (Past-president Am. Soc. C. E.), H. R. Leonard and J. E. Greiner, as a commission to review and either approve or disapprove. This commission reported its opinions under date of March 8, 1909. The two reports have been published together in pamphlet form by the steel company. From a copy of the pamphlet sent us we abstract the following brief summary.

The concise opinion of the Commission is chiefly occupied with discussing the loading which should govern the design of the bridge, i. e., the amount and distribution of live-load. There is also a brief statement of the situation as to dead weight, whose purport is that the increase in dead weight which occurred after the designs were made is minor and unimportant. But the subject of dead weight is more fully stated in Mr. Kunz's report; and as there are some discrepancies between the Commission's figures for dead load and those of Mr Kunz, we have omitted this passage of the Commission's opinion. The remainder we give substantially in full as follows:

Opinion of Commission of Review.
(Slightly condensed.)

The public confidence, which was disturbed by the Quebec failure and by the unwarranted comparison of that bridge with the Blackwell's Island Bridge structure, has certainly not been restored by the reports of the city's experts on the latter bridge. In fact, the strength of the Blackwell's Island Bridge has now become a question of such serious and far-reaching importance, affecting not only the confidence of the public in engineering works, but the professional standing of American engineers, that it is assuredly proper and advisable for the contractors to make available their knowledge of the situation; and the undersigned, at the request of The Pennsylvania Steel Co., as conveyed in your letter of Dec. 22, 1908, have reviewed the report of your Chief Engineer covering this subject.

We have carefully examined this report, dated Nov. 27, 1908, together with all data and information furnished in connection therewith, including the specifications, contract, strain sheets, reports of experts, etc., etc., and substantially endorse the arguments, conclusions and recommendations therein set forth.

Our report should, in our judgment, be an answer to the unjust and disturbing criticisms that have appeared in the public prints rather than a résumé of the entire subject; the structure has been so overloaded mathematically that the confidence of the public has been shaken, and it is only by an appeal to common sense, rather than to technicalities, that this lost confidence can be regained.

No question has been raised as to the sincerity of the contractors in executing the work; and the quality of the material, character of workmanship and adherence to approved plans have been endorsed by the city's experts. It is our understanding, after careful study, that the contract gave free powers to the Bridge Department in general design and engineering changes, and does not presuppose engineering knowledge on the part of the contractor further than is necessary for the proper execution in detail of the general orders of the Department.

CRITERIA OF SAFETY.—The entire argument can well be based on the consideration of this question: Were the original specifications, and the subsequent modifications, made by the Bridge Department, of such a nature that there can be any engineering doubt as to the safety and usefulness of this structure as a public highway?

A bridge is a highway and is not designed primarily to carry so many pounds per linear foot, but to accommodate so much traffic, and from an estimated weight of such traffic the design is perfected. For a railroad bridge such weights are easily determined, but for a roadway structure the determination of live load weights is largely a matter of good judgment.

No material difference of opinion can arise as to the proper loading to be assumed in the designing of minor parts, i. e., hangers, floor-beams, stringers, etc.; such loading would cover but small areas and a maximum density of traffic could easily be conceived, but for the main trusses in a structure of any magnitude, the application of live loads of maximum density ("congested") over any extended areas would preclude all possibility of motion, a condition that would destroy the usefulness of the structure as a vehicle of traffic, a condition so absurd that it would not be tolerated in a city street.

The measure of usefulness of any public highway is the amount of traffic that can be safely and expeditiously handled over same, and any police regulation made for the proper handling of such traffic is a necessity for the benefit of the traveling public and does not, in itself, lessen confidence in the structure.

Traffic rules requiring the surface cars to keep to certain clear distances apart are no hardship; quite the reverse, in allowing for greater freedom of motion, they are in the interest of increased traffic and consequently increased capacity. On elevated railroad tracks, proper spacing of trains is a measure of safety, and the greater the interval of space, the greater could be the permissible speed; block signal and automatic devices now in use absolutely prevent electric trains from encroaching on the space deemed necessary for their prompt and safe handling.

THE MEANING OF "CONGESTED LOAD."—In this connection, we wish to call attention to the investigations of a Commission appointed in 1903 by the Mayor of New York City to examine and pass upon the plans of the Manhattan Bridge, which was then designed as a suspension bridge with stiffened eyebar cables. While the report of this Commission refers wholly to the Manhattan Bridge, the recommendations as to the live loads for which it should be designed have been applied to the Blackwell's Island structure, which was intended to carry the same kind of traffic. This Commission, consisting of Messrs. George S. Morison, C. C. Schneider, Henry W. Hodge, Mansfield Merriman and Theodore Cooper, made a very thorough investigation of the subject and recommended that the Manhattan Bridge should be designed, in so far as the main members are concerned, to carry a "maximum working" load of 8,000 lbs. per lin. ft., and that a so-called "congested" load of 16,000 lbs. be used in proportioning the hangers. Quoting from this report, in regard to further use of the "congested" load,

We consider that the bridge should be so proportioned that with a congested load of 16,000 lbs. per lin. ft., covering the whole bridge, combined with dead load and wind pressure, no stresses should be produced anywhere reaching the elastic limit of the material or impairing the stability of the anchorages. We consider that the working load of 8,000 lbs. per lin. ft. should

be used in designing the main members of the structure. The congested load should be used in proportioning the hangers.

Any fair interpretation of this report would indicate that the intention of the Commission was to recommend the use of the "congested" load for proportioning the hangers (using a working-unit stress) and as an extreme test of the cables and anchorages; and that the "working" load be used in proportioning the main members of the structure. The above quotation appears (in part) in the report of one of the city's experts, but the omission of the words "or impairing the stability of the anchorages" and the omission of the last two sentences quoted above, admits of an entirely different construction being placed on the recommendation.

Independent investigations which we have made confirm the estimate of the Manhattan Bridge Commission as well as that of the city's experts, fixing the maximum load on any extended area of roadway or footwalk at 50 lbs. per sq. ft. With the increased weights of elevated and surface cars, cited in the experts' reports, we would obtain as a "congested" load 15,955 lbs. per lin. ft., made up as follows:

	lbs. per lin. ft.
4 elevated 8-car trains, at 1,810 lbs. per lin. ft...	7,240
4 trolley tracks, at 1,400 lbs. per lin. ft.....	5,840
35.5 ft. roadway, at 50 lbs. per sq. ft.....	1,775
22 ft. footwalk, at 50 lbs. per sq. ft.....	1,100
	15,955

Such a load, with roadway and footwalk crowded, trolley cars bumper to bumper, and elevated tracks completely covered, is an *impossibility* unless special and extraordinary means were taken to produce it, and the term "congested" applied to such a loading in connection with the computations of stresses in main members is misleading; *"theoretical test load"* or "extraordinary load" would be terms more applicable.

WORKING LOAD.—*A maximum working load* is much more complex of analysis than a "congested" load, and is a matter on which the judgment of engineers may be expected to differ. With a "congested" load provided for, the possibility of failure from collapse is eliminated, but to provide for such a load at ordinary working units would be an unwarranted extravagance, hence the economical necessity for determining a working load and providing for such loading with working units. The working load of 8,000 lbs. per lin. ft. of bridge recommended by the Manhattan Bridge Commission and used in the computations of the Blackwell's Island structure by the Bridge Department could be analyzed as made up of 20 lbs. per sq. ft. on the footwalks (an uncomfortable walking crowd), 30 lbs. per sq. ft. on the roadway (equivalent to a semi-congestion of average vehicles), 1,945 lbs. per lin. ft. on four trolley tracks (equal to heaviest loaded cars spaced two car-lengths apart) and 4,550 lbs. per lin. ft. as an equivalent load for the elevated trains on four tracks, trains spaced about 1,000 ft. apart; such loading can be conceived, but it is doubtful whether these weights would be reached once in a period of years.

DISTRIBUTION OF LIVE-LOAD.—The design of this structure, a cantilever bridge without a suspended connecting span, gives a continuity not found in the ordinary cantilever, inasmuch as a load on any part of the bridge affects the stresses in the entire structure from end to end. A strict interpretation of the specifications requires the loads to be placed in such positions as to give the greatest stress on any member of the structure. The Bridge Department, in preparing the strain sheets from which the bridge was built, did not strictly follow this clause, and applied the loads, both "working" and "congested," in one continuous stretch, this stretch of any length covering one or more of the subdivisions of the bridge or the entire length of the structure, but with no unloaded gaps. The city's experts, in making their analysis of the structure, interpreted the specifications literally, and obtained stresses (the mathematical accuracy of which we do not question) alarmingly high, when considering the "congested" load together with the increased weight of pavement.

A reasonable and proper distribution of assumed live-load on a structure of this type and magnitude is again a matter of engineering judgment.

The adopted method of the Bridge Department was well within their rights, especially as regards the so-called "congested" load, and it is our judgment that such placing of the loads would cover all possible contingencies liable to arise.

The alarmingly high stresses obtained by the experts, as stated before, were arrived at by a strict interpretation of the printed specifications by placing the "congested" load of 16,000 lbs. per lin. ft. on certain fixed portions of the bridge with fixed lengths of gaps in which there could be no load whatever; a method that might well be described as the placing of impossible loads in an impossible manner.

Professor Burr's method of calculation of stresses produced by the elevated trains, spacing eight-car trains in position to give maximum stress, but not less than 1,000 ft. apart, is rational, and we fully endorse his method; but, when more than one track is treated in this manner, some concession should be made either in unit stresses or weight of trains, for economic reasons. The possibility that two or more trains of 410 ft. length (eight cars) fully loaded, occupy exact spaces on one track, should be provided for; that this same loading and spacing could occur on a second track at the same instant of time is only conceivable, but that all four tracks should be loaded in this exact manner is well nigh impossible, and places such loading immediately in the category of "congested" loads to be provided for by a higher unit.

According to Professor Burr's conclusions,

> a controlled traffic on the four trolley lines of the lower deck and on two elevated railways of the upper deck, carrying the heaviest cars of their classes now in use in the City of New York, together with a vehicular traffic on the roadway, and two loaded sidewalks, may be permitted without exceeding the specified unit stresses for the regular live load and dead load and without exceeding the safe limits of stresses for such a structure.

This conclusion was based on reducing the dead load by a considerable amount.

We have made an investigation, using Professor Burr's method of distribution of train load on *four* elevated tracks, together with 8,000 lbs. per lin. ft. of bridge, and find that the stresses produced by this extreme load practically agree with those specified for the congested load, and are, therefore, well within the limits of safety.

Considering the character of the structure and assumed loads, the unit stresses specified and used in the computations were conservative; a distinction should be made, however, between unit stresses for "working" loads and "congested" loads. The city's experts recommend, with one exception, the unit stresses for working loads fixed by the specifications, the exception being a slightly higher unit for steel in compression, due to change in reduction formula. One of the experts, after listing "working" unit stresses substantially in accord with the specifications, stated that these stresses "are the *limit of safety* for the direct stresses from the sum of the live and dead loads, as the secondary and snow load stresses heretofore referred to will add to these stresses." The secondary stresses are small, especially in the tension members, where the higher units are specified, and we believe that a snow load may be safely neglected when considering working or "congested" loads; it would, therefore, seem that the term "limit of safety," as applied to such working stresses, was unfortunate and tending to cause unnecessary alarm. The "limit of safety" would, in a theoretically perfect structure, be just under the elastic limit of the material; secondary stresses and imperfect distribution of stresses should be allowed for, and we believe that sufficient allowance was made for such factors in the specifications, in fixing on the unit stresses to be used in connection with the "congested" load.

CONCLUSIONS.—(1) We are of the opinion that the live loads provided for in the original specifications, with the subsequent modifications made by the Bridge Department, both as to weights and distribution of same, are sufficient for the traffic the bridge is intended to carry, and cover all possible contingencies.

(2) That the unit working stresses specified are in accordance with good practice, and the limiting stresses for extreme conditions of loading are well within safe limits.

(3) That the actual weight of steel superstructure practically agrees with the estimated weight used in calculating the stresses, within the usual allowance permitted in bridge work.

(4) That the superstructure, as built, conforms to the specifications and designs approved by the Bridge Department.

(5) That the bridge, as now constructed, with provision for two elevated tracks is entirely safe to carry all traffic which can possibly come upon it under present conditions,* without any other restrictions than those necessary to regulate such traffic.

(6) That, for conditions of traffic, i. e., the weight of vehicles, surface and elevated cars, as now existing, the bridge would also be safe to carry all the lines of traffic contemplated in the final design of the bridge† subject to ordinary traffic regulations.

The report of Mr. Kunz, reviewed by the above-mentioned Commission, is very much lengthier, and argues more in detail. We can give it only in much condensed form. It is accompanied by several sheets of diagrams showing how the live-load was distributed under the two different assumptions at issue: (1) continuous lengths of load, and (2) discontinuous lengths of load. What these mean may be illustrated by the case of the chord-members of the Island Span, which theoretically experience maximum stress when the two channel spans are fully loaded and the intervening Island Span is empty. For these members the "discontinuous" loading follows the theoretical distribution, i. e., it consists of full live-load on both channel spans, two separated stretches of maximum load, with no load on the island span; the "continuous" loading, on the other hand, is a single stretch of full load extending over both channel spans [illegible] the island span. This comparison illustrates [illegible] case fully enough that we may dispense with reproducing the diagrams in question. The [illegible] roversy, as to which arrangement of loading should be taken as basis of the design, hinges on the question whether it is reasonable or even conceivable, that maximum concentration of [illegible] can occur on two isolated but definitely located stretches, with no load whatever on the rest of the bridge.

The report also gives tables of [illegible] live and total stresses in the trusses for three different arrangements of live-load: (1) continuous sections, (2) discontinuous, and (3) the mean of the two, or half the total load continuous and half discontinuous. Those for full load in discontinuous arrangement, naturally, agree fairly well with the stresses computed by the experts as reproduced in our issue of Nov. 19, 1908, [illegible] 557-560, except that Mr. Kunz's dead-load figures represent the condition with light paving (not the heavier paving, railing, etc., which was actually put in by the Department of Bridges). As concerns the stresses for the live-load arranged in continuous sections, it will not be necessary to give the tables here, as the report states that for this loading the stresses do not materially overrun the specified unit-stresses.

Extracts From Report of F. C. Kunz.

The reports of the Consulting Engineers, Prof. William H. Burr and Messrs. Boller & Hodge, appointed June 9 by the Commissioner of the Department of Bridges of the City of New York, in accordance with the resolution of the Board of Estimate and Apportionment, dated June 5, to examine "the design and structure" of the Queensboro Bridge, formerly called Blackwell's Island Bridge, are now public property. Coming from such an eminent source, the conclusions of the reports have been accepted without question, and much unfavorable criticism of the design of the bridge followed. It would, no doubt, interest the profession to know that there are engineers, not responsible for the design, who do not agree with all the conclusions of the reports. It would seem that the experts were not in possession of all data concerning the design, which would not be surprising, considering the fact that the construction of this bridge was directed by three different administrations of the Department of Bridges. Furthermore, while the reports are fair, they are based on assumptions different from those originally made.

HISTORY OF THE LIVE-LOAD IN THE DESIGN.—The original specifications for the Blackwell's Island Bridge, written in 1903, prescribed a "regular" live load of 6,300 lbs. and a "congested" live load of 12,000 lbs. per lin. ft. of bridge, which in April, 1904, were changed to 8,000 lbs. and 16,000 lbs., respectively, when the Department of Bridges decided to add two elevated railroad tracks, making the traffic facilities equal to those of the Manhattan Bridge. These live loads were adopted from a report submitted to the Department of Bridges early in 1903, by a commission of bridge experts appointed to examine and pass upon a design of the Manhattan Bridge with eyebar chains. The specifications for both bridges having been written at the same time, it would have been surprising had the specified loads not been the same.

The Commission on the Manhattan Bridge did not specify any unit stresses under the action of the two kinds of live load except that "such extraordinary congested load should not do any permanent injury to the bridge." The specifications for the Blackwell's Island Bridge, prescribed for tension of truss members 20,000 lbs. per sq. in. for "regular" or working, and 24,000 lbs. per sq. in. for "congested" or extraordinary live load, with more than the usual reduction for compression, viz., 20,000—90 *l/r* and 24,000—100 *l/r* respectively. Professor Burr calls these stresses "safe and satisfactory in the light of knowledge and precedent available when they were drawn" (in 1903) and, since the amount of the "regular" and the "congested" live load was also specified and actually used in the calculations, it would only remain to explain how this live load was placed to obtain the greatest stresses.

The specifications stated that the live load should be "placed so as to give the greatest strain in each part of the structure." This is the usual wording used in specifications for bridge work. For ordinary trusses, the live load causing the greatest strain or stress in each truss member covers one continuous, i. e., uninterrupted stretch. However, in arches, most types of suspension bridges, like the Brooklyn and the Manhattan Bridges, swing bridges or trusses with several supports, like the Blackwell's Island Bridge, the live load for the greatest theoretical stress in some members would have to cover certain discontinuous, i. e., isolated stretches, different for different groups of members, with absolutely no live load between these stretches and

*That is, with two elevated-railway tracks.—Ed.
†With four elevated-railway tracks.

on the other parts of the bridge. Any live load outside of these isolated stretches would reduce the greatest stress in the truss members.

The usual method, however, is to assume a continuous i. e. uninterrupted stretch loaded. This method was followed in the design of the Blackwell's Island Bridge.

In March, 1904, the contractor was furnished with the "Loading Key" (dated Jan. 26, 1904), prepared by the Department of Bridges. (See paper by Mr. R. C. Strachan, Assistant Engineer of the Department of Bridges, published in the Proceedings of the Engineers' Club of Brooklyn, 1905; also in Engineering News, Feb. 16, 1905, in which the analytical method of computation is described; also paper by Mr. F. H. Cilley, in the Transactions of the American Society of Civil Engineers, 1904, describing the graphical method used for checking the live-load stresses.) This "Loading Key" gives the influence on the stresses in the different truss members of a live-load of 1,000 lbs. per ft. per truss, covering different adjoining stretches of the bridge.

The original estimate of the contract of the Blackwell's Island Bridge, with two elevated railroad tracks, made in 1903, was about 86,000,000 lbs.; the addition of two elevated railroad tracks to the capacity of the bridge, with changes and additions made by the Department of Bridges in 1904, as well as more specific knowledge in regard to the probable weight of details, indicated that, with the live-load in continuous stretches, the total steel weight would run up to about 100,000,000 lbs., with a greatest cross-section of the bottom-chord of the trusses equal to about 1,100 sq. ins., while, for the live-load in discontinuous stretches, the total steel weight would be about 10% and the chords about 25% heavier, with all the accompanying difficulties of excessive thickness of material, inadequate space for the lacing of bottom-chord and for the packing on the pins, etc.

The question of continuity or discontinuity of the live-load, therefore, involved a question of an increase of the steel weight of the structure of about 10,000,000 lbs., at a corresponding additional cost of approximately $700,000.

The adoption of the continuous live-load by the Department of Bridges was based on the unlikelihood that the fourteen lines of live-load, consisting of four kinds of traffic, i. e., rapid transit trains, trolley cars, wagons and pedestrians, on two independent floors, would be distributed simultaneously in the following manner, viz.:

First—Each kind of traffic up to its assumed "regular" or "congested" maximum per lin. ft.;

Second—Each separate kind of traffic in two or three isolated stretches only, these stretches being in certain exact distances from each other and from the ends of the bridge;

Third—These stretches and distances to be alike, i. e., in the same location for all the fourteen lines of traffic on the two floors;

Fourth—Absolutely no other live-load on the bridge.

Such conditions of loading could scarcely be produced, even as an experiment, since trains, cars, wagons and horses each cover certain definite spaces.

The Department of Bridges, therefore, adopted in 1904 the following conditions for designing the truss members, Nos. 1 and 2 providing for continuous live-loads, while Nos. 3 and 4 take account of extraordinary conditions that might arise from discontinuous loading, viz.:

(1) The "regular" live-load of 8,000 lbs. per lin. ft. of bridge in one continuous stretch for each member, over such a portion of the bridge as to cause maximum stress, and using 20,000 lbs. per sq. in. in tension (reduced for compression) for structural and 30,000 lbs. per sq. in. in tension for nickel-steel as permissible without wind acting, and increased 20% with wind acting.

(2) The "congested" live-load of 16,000 lbs. per lin. ft. of bridge in one continuous stretch for each member, over such a portion of the bridge as to cause maximum stress without wind, using 24,000 lbs. per sq. in. in tension (reduced for compression) for structural and 39,000 lbs. per sq. in. in tension for nickel-steel as permissible.

Of these two conditions, the one causing the greater cross-section in each truss member should be taken.

(3) If the "congested" live-load of 16,000 lbs. per lin. ft. of bridge in discontinuous stretches (without wind acting) causes an absolute maximum compression greater than the dead-load tension in a member, such member to be made of a section able to withstand the resulting compression.

(4) Furthermore, in order to be sure that no overstressed condition could result from the "regular" live-load of 8,000 lbs. per lin. ft. of bridge, in discontinuous stretches causing absolute maximum stress without wind, the unit stresses are to be analyzed for this condition.

For this last condition, the greatest unit stress in tension, with two exceptions, would not be greater than 20,700 lbs., and in compression 18,800 lbs. for l/r=27 for structural steel and 34,100 lbs. in tension for nickel-steel, the exceptions being the verticals U59-L59 and U73-L73, which are stressed in tension to 22,900.

The combination of live-load with the greatest wind pressure was considered for condition (1) only, and the unit stresses increased by the usual amount of 20%, since it is hardly possible that the bridge will be crowded on the roadway and the promenades in stormy weather. A concurrence of a great wind pressure with conditions (2), (3) or (4) is practically impossible.

The wind pressure was assumed at 2,000 lbs. per lin. ft. of bridge, representing about 35 to 40 lbs. per sq. ft., which would be caused by a velocity of wind of 100 miles per hr.; and it is clear that in the same degree as the wind pressure increases, the live-load on the roadway, promenades, etc., naturally decreases, which is distinctive of highway bridges as compared with railroad bridges, since, in the latter, the maximum live-load will pass irrespective of the velocity of the wind.

To illustrate: For the top and bottom-chord, in fact for most truss members of the Island span, where, according to the reports of the experts, the highest stresses occur, the continuous "congested" loading covers the distance between piers Nos. 1 and 4; i. e., both river spans and the Island span, a total length of 2,796 ft., while for the discontinuous loading the "congested" load would cover the distance of 1,182 ft. between piers Nos. 1 and 2, no live-load whatever for a distance of 630 ft. between piers Nos. 2 and 3, and again, the "congested" live-load for a distance of 984 ft. between piers Nos. 3 and 4; whether loading is continuous or discontinuous, both anchor spans have to be absolutely free of any live-load. The possibility that the "congested" live-load of 16,000 lbs. per lin. ft. of bridge, representing 14 lines of traffic of four different kinds on two independent floors of uniform construction from end to end of the bridge, will cover 1,182 ft., is indeed very small; that another bunching of traffic on all 14 lines on the two floors precisely in the same location for a length of 984 ft. will occur, is still smaller; but what can be the possibility that these two loaded stretches will be 630 ft. apart with no live-load on the two floors between them, a distribution which even for the working live-load of a single-track railroad bridge would be exceptional?

It would not be surprising if some engineers, differing honestly in their judgment from that of the designers, would reverse the question and claim that the "congested" live-load of 16,000 lbs. per lin. ft. of bridge, even in a continuous stretch of 2,796 ft., representing a distribution of cars, wagons, pedestrians, as shown on plate No. 7, from piers Nos. 1 to 4, and no other live-load on the two floors from these piers to the abutments, is a practical impossibility; that therefore the Island span has been wastefully designed by the Department of Bridges and that the engineers of the contractor must have known this and should have protested even if the bridge was paid for by the pound.

This is followed by a further argument against assuming discontinuous arrangement of live-load, but its general tenor is already well enough represented.

The report then discusses briefly what allowance should be made for impact effects, snow load and temperature expansion. Impact is negligible, of course, not only because of the solid floor and the light, short railway trains, but also because of the great lengths of loading required to produce maximum stresses.

Temperature is shown to produce stress only in one of the Island towers, and here the maximum bending stress due to 60° F. temperature change is computed to be only 3,200 lbs. per sq. in., bringing the total stress up to 18,400 lbs., against 20,000 lbs. permissible.

Snow load, Mr. Kunz considers, should not be counted simultaneous with maximum live-load, as in weather when snow or ice are on the bridge the traffic will surely decrease by a larger amount than the weight of the snow.

DEAD-LOAD.—He then takes up the interesting subject of dead weight. His figures explain how and why the weight increased steadily from 1903 to the completion of the structure. They also show that the members of the Island Span were already fabricated when the final computation of weight was made, i. e., they were designed on the basis of a weight 10% less than really resulted. Moreover, it is shown that even after this period the Department of Bridges added much extra weight in the form of heavier paving, etc.

The statement has been made that the dead-load stresses of the Blackwell's Island Bridge were considerably underestimated. This is only partly correct.

The original estimate of the steel weight, made by the Department of Bridges, was 86,600,000 lbs. Beginning early in 1904, the Department ordered changes and additions made, such as changing the tracks of the upper floor from longitudinal ties with bulb angles to wooden cross ties, addition of two elevated railroad tracks, reduction of pressure of the tower bases on the masonry, replacing the pin-bearing of the bottom of the towers by a flat bearing, additional sway bracing, bottom and top laterals, top struts, bracing between stringers, secondary verticals from the middle pins to the top-chord, etc., all this increasing the steel weight to about 95,000,000 lbs., with a total dead load of 116,000,000 lbs. New dead-load stress sheets were made by the Department, and at their suggestion, also by the contractor subject to their approval, in order to hasten the time of the ordering of the material. To these dead-load stresses, the live-load stresses calculated by the Department for the new live-load (with four elevated railroad tracks) were added, the sections of the truss members determined and all section sheets which the contractor prepared for use in his own drawing-room were submitted to and finally approved by the Department with certain changes.

Shop drawings for the Island Span were now made by the contractor and approved by the Department with changes, and the material ordered.

In the meantime, new dead-load concentrations and new stress sheets were worked out, finished about November, 1904, based on a new estimate of the steel weight of 100,750,000 lbs., giving with the originally prescribed weight of paving, pipes, etc., a total dead load of 122,130,000 lbs. As far as possible, the old stress and section sheets were then revised. To change the material for the Island Span, at that time in the process of manufacture in the bridge shop, was impossible, and it is here that some dead-load stresses figured with these new dead-load concentrations slightly overrun the older figures.

The actual shipping weight of the bridge proper (deducting test eyebars and other test material) is about 105,150,000 lbs., which, of course, includes all changes and additions made after November, 1904, as reinforcing certain trolley stringers for elevated railroad trains, strengthening of the anchorages, etc., giving a total dead load of 125,680,000 lbs. It should be stated in this connection that certain changes in the design, which caused a considerable addition to the steel weight, did not affect the dead-load stresses, as strengthening of the anchorages, increase in weight of tower bases and towers, in the weight of the box girders between trusses at the piers, in the weight of the shoes on top of the towers, etc.

In the meantime, the Department changed the plans for the paving. The original paving, consisting of concrete and wooden blocks, was intended to be as light as possible and to extend only between the curbs for 35½ ft.; the tee-rails for the inside trolley tracks were to be 5 ins. high and their top about 6 ins. above top of stringer; the buckle plates between the rails merely covered with asphalt and the rails free. The Department now decided to extend the paving over the whole roadway between the trusses (53 ft.) with heavy cast-iron curbs and of much greater thickness, using 7-in. grooved rails with their tops nearly 12 ins. above the top of the stringer, and imbedded entirely in concrete. If ordinary concrete and not cinder concrete be used, this makes the paving about 1,341 lbs. per lin. ft. heavier than originally intended and assumed in the calculations, increasing the total dead load to 132,300,000 lbs., which figure was used by the experts in their calculations of the dead-load stresses.

The change in the paving was an after-thought, not concerning the contractor, since at that time the bridge was completely manufactured, and, in its greatest part, erected. This, and the fact that the additional paving being of uniform weight over the whole bridge, forms a larger percentage of the dead load near the ends of the cantilever arms, where its influence on the stresses is the greatest, accounts for the great difference in the dead-load stress as used for the design of the bridge and as calculated by Professor Burr and Messrs. Boller & Hodge.

The writer understands that the Department of Bridges recalculated the dead-load stresses after arranging for heavier paving, and that they got the same excessive figures as the experts, but that they had not come to any conclusion pending a recalculation of the live-load stresses when the experts were invited to make a report.

RATIO OF DEAD TO LIVE-LOAD.—Although it does not seem within the scope of this report, it may nevertheless be useful to mention, for the information of those critics of the Blackwell's Island Bridge who are not experts in bridge engineering, that the excellence of the design of different bridges cannot be judged by the proportion of the steel weight necessary to carry a pound of live-load. This depends for bridges of similar character almost entirely on the length of the span. For a very short span, one pound of steel may suffice to carry 100 lbs. of live-load, and for a very long span the reverse may be the case. The proportion of steel weight to the assumed working live-load is for the following bridges approximately:

	Greatest Span, ft.	Ratio of Steel to Live-Load.
Thebes bridge	671	1.0
Monongahela bridge	812	1.0
Memphis bridge (one track only)	790	1.7
Blackwell's Island bridge (heavy solid floor)	1,182	3.4
Quebec bridge	1,800	4.3
Firth of Forth bridge	1,710	4.7

The Blackwell's Island Bridge carries a heavy solid floor, the others only wooden ties. If the former had had a light wooden floor, possibly 2.5 lbs. of steel instead of 3.4 lbs. would have been sufficient to carry a pound of live-load.

The subject of secondary stresses is then considered, with the conclusion that the effect of such stresses is often over-estimated. Mr. Kunz refers to the fact that in solid sections of metal, as pins, higher bending stresses are allowed than in lighter sections, which he explains on the ground that in solid sections the inner fibers of metal relieve the higher-stressed outer fibers. He argues that in built members as heavy as those of the Blackwell's Island Bridge a similar allowance should be made, in other words that the sum of direct and secondary stresses should be credited with a higher unit-stress than that specified for direct stresses alone.

There follows then a comparison of the Quebec Bridge with the Blackwell's Island Bridge, to show that the unit-stresses specified for the former were effectively much higher. Mr. Kunz takes special exception to a statement contained in the report of the Royal Commission on the Quebec Bridge accident, who said that the stresses specified for that structure were "in general harmony" with those specified for the Blackwell's Island Bridge.

The final conclusions of his report are as follows:

CONCLUSIONS AND RECOMMENDATIONS.—(1) The paving should be reduced to its originally intended weight on the whole bridge, or, which may be even more effective for its final purpose of reducing certain stresses, reduce the paving only on the river spans, leaving on the Island Span and the two anchor arms the heavy paving, as the writer suggested to you about three months ago, before the reports of the experts were known.*

(2) With the paving altered in this way, the bridge is safe for the intended traffic, viz.: two promenades of 11 ft. each, a roadway of 35½ ft., four trolley tracks of 1,000 lbs. per lin. ft., and four elevated tracks of 1,700 lbs. per lin. ft.

(3) The experts state that, since the bridge was designed, the weight of trolleys and rapid transit trains increased, the former from 1,000 to 1,460 and the latter from 1,700 to 1,810 lbs. per lin. ft. This may or may not be only a passing phase in the development of the rolling stock of electric traffic. In the next few years, before any rapid transit traffic will cross the Blackwell's Island Bridge, many changes in the rolling stock may occur, the cars may get longer, or the character of the traffic may change (moving seat platforms, etc.), and the calculations will have to be revised for the new conditions.

(4) To remove the stringers designed to carry two elevated railroad tracks is not necessary, and not advisable, as they now support the footwalks and new ones would have to be provided to replace them, and, as nobody can tell whether they may not be of use within the next ten years, should the weight or character of rapid transit traffic change.

(5) A thorough investigation of the actual traffic on the existing bridges in New York City should be made by the engineering staff of the Department of Bridges (not by laymen) in order to prove conclusively that the traffic needs no police regulations, beyond those customary in the case of ordinary city streets on which "congestion" or "bunching' of traffic to the extent of 50 lbs. per sq. ft. over any great area would not be tolerated by the police, and to establish again that sense of proportion which, in this whole controversy, seems to have been lost.

In taking instantaneous photographs of the traffic of the Williamsburg, the Brooklyn and other bridges, possibly also on crowded streets (from an upper story) and approximating from them the live-load over a certain length, a fair estimate of the weight per square foot at different hours and its maximum could be established, while the usual assumptions of 50, 75 or 100 lbs. per sq. ft., derived from experiments in buildings with stationary live-loads, are for floors of long bridges hardly better than guess-work.

A PHENOMENAL FREIGHT TRAIN was hauled over the new Virginian Railway a few days ago. It weighed 6,023 tons behind the tender, of which 4,310 tons was lading (coal). The train was made up at Victoria, 120 miles from Norfolk, Va., and was hauled through to the eastern terminus at Norfolk. It consisted of 80 coal cars of 50 tons capacity each. No trouble was experienced during the haul, and it is stated that the same train could just as readily have been hauled over 350 miles of the 446-mile road. The tonnage stated refers to tons of 2,000 lbs., of course. A new Mikado type (2-8-2) locomotive hauled the train. The railway was opened for regular traffic only in April of this year, shortly before the death of its projector, H. H. Rogers. It was planned throughout for heavy freight, and generally has 0.2% maximum gradients.

The Accident to the Lock Gates at the Canadian Canal, Sault Ste. Marie.

On June 9, 1909, at 12.30 p. m., the lower gates of the lock of the Canadian Canal at Sault Ste. Marie, Ont., were wrecked by a steamer on the lower level and the water rushing through the open upper gates carried with it two other steamers waiting in the lock to go down. One of the ships was seriously damaged and the main lock-gates were completely destroyed. Through Mr. L. C. Sabin, M. Am. Soc. C. E., General Superintendent of the St. Mary's Falls Canal on the American side of the river at Sault Ste. Marie, we are enabled to present the following account of the accident.

The Canadian Canal on the north side of the St. Mary's River at Sault Ste. Marie, shown in the upper part of the map in Fig. 1, is 1⅛ miles long, 150 ft. wide and 22 ft. deep, with a lock 900 ft. long and 60-ft. wide, with 22 ft. of water on the miter sills. It was built from 1888 to 1895. The lock is provided at each end with two sets of gates of ordinary wood construction, in addition to a pair of low-level gates at the lower end, used for emptying or repairing purposes. At the lower end both sets of high-level gates can be used for closing the lock, although the pair nearest the end were used as the regular service gates and the other pair reserved for occasions when the regular pair were out of commission. At the upper end the regular gates only can be used in locking because the draining culvert is between the two sets of gates. The upper pair of gates there, then, served only as guard gates.

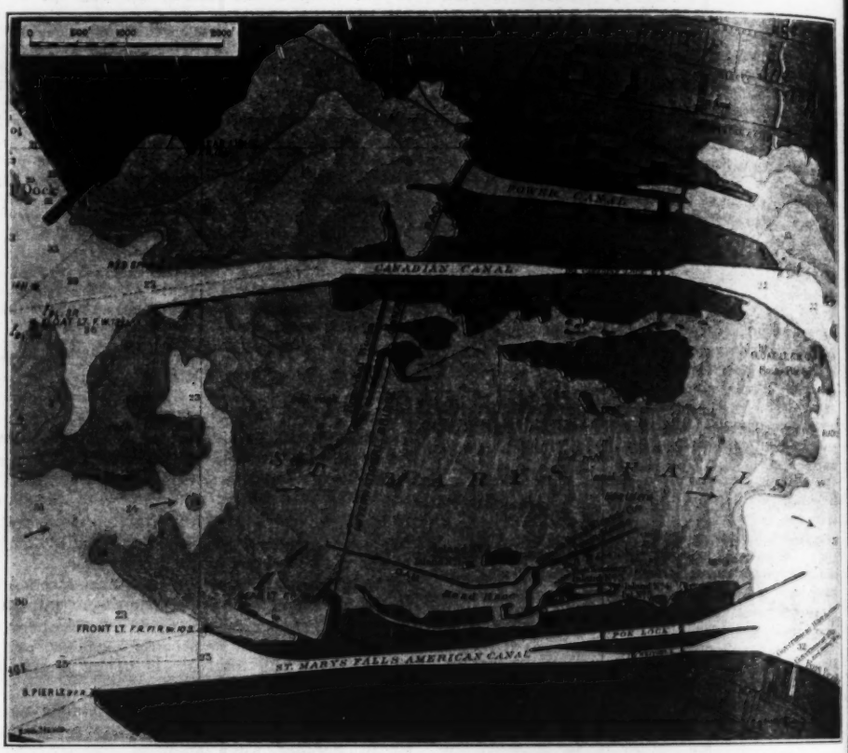

FIG. 1. MAP OF SAULT STE. MARIE AND VICINITY SHOWING THE CANALS AROUND ST. MARY'S FALLS.

(From a map prepared by the Corps of Engineers, U. S. A.)

These locks are operated by electrical power generated by the near-by power canal. Near the upper mouth of the canal, just east of the railway drawbridge of the Canadian Pacific Ry., there is a movable dam which was installed some 12 years ago to shut off the flow through the canal when necessary, but in all these years there has never arisen, until the present, the necessity of operating the dam under excessive conditions of flow.

On the morning of June 9, the passenger steamer "Assiniboia" and the freighter "Crescent City" had just tied up in the lock, bound downstream, with the upper gates open and the lower gates closed. In the lower approach to the lock the freighter "[illegible] G. Walker," was bound up-stream, waiting for the passage of the two other steamers through the locks. She had not tied up as yet to the [illegible] purpose but was maneuvering [illegible] through some mistake or [illegible] orders, the engineer put on [illegible] drove the boat directly against the lower lock gates, which were at that time holding back the 20-ft. head of water in the [illegible].

The boat probably struck [illegible] center, forcing back the gate [illegible] and allowing the opposite gate, the instant the support at its miter end was removed, to swing down-stream, impelled by the enormous pressure behind it, followed immediately by the other gate. There was thus [illegible] through the lock for the 20-ft. head of water, and it poured down like a tidal wave, carrying the "Walker" before it into the wider channel below. The "Assiniboia" and the "Crescent City" were also carried down on the crest of the wave and finally passed the "Walker," ripping holes in her as they went by. The "Assiniboia" was controlled before sustaining any great damage, but the heavier ore-laden "Crescent City" stove a hole in her hull in passing the hanging gates and was finally beached near the docks downstream. The "Walker" only needed some slight repairs to enable her to get to her port.

When the rush of water started through the canal the main upper gates were open, against the up-stream wall of the lock, but not fastened thereto. The rushing water swung them into the stream and tore them entirely from their hinges. It has been noted that inside of the lower and outside the upper lock gates there are guard or intermediate gates provided. These gates are shown in position on the map in Fig. 1 and may be seen in the views, Figs. 2-4. At the time of the accident, however, both boats in the lock had tied up to the walls, and the upper guard gates were not closed, but were in their open position back in the recesses in the walls of the lock. Consequently they did not serve to retain the water nor were they damaged by the torrent of water or by the boats.

The accompanying three photographs, taken on June 10, show the lock immediately after the accident. Fig. 2 is a view taken from the upper end of the lock, looking down-stream. In the immediate foreground may be seen the guard

FIG. 2. VIEW OF CANADIAN LOCK LOOKING DOWN-STREAM FROM UPPER GATES.
(Copyright 1909 by Young, Lord & Rhoades.)

gates safe in their recesses; below them are the recesses from which the main upper gates were torn. Fig. 3 is a view of these same sets of gates, taken looking up-stream. Fig. 4 is taken from below the lower gates looking up-stream, and shows the main gates torn from their hinges and hanging against the side walls. Farther up-stream is one of the intermediate gates, which was not damaged, the opposite one is obscured by the wall. In front of the hanging gate on the left-hand side may be seen the low-level gate referred to above.

Immediately after the accident every effort was made toward closing the movable dam some 1,000 ft. west of the upper gates. This dam is the nearest of the two trusses shown in the background of the view in Fig. 3. It is practically a center-bearing swing-bridge, resting on a pier on one side of the canal, with one of its 150-ft. arms extending, when in service, over the canal and the other over the land and acting as a counterweight to the canal span. Normally the bridge is parallel to the canal; it is swung into place by hand power. From the lower chord of the canal span there can be lowered, one by one, 23 girder frames each spaced about 6½ ft. apart, and engaging a sill at the bottom of the canal. The frames, which normally are stored away close under the lower lateral system of the bridge, are made up of interbraced double girders, and the final closure of the canal is made by letting down between each set of double girders a wicket 6½ ft. wide made of buckle-plates fastened to rollers, which move on the vertical girders.

On the whole, the dam acted excellently in making the closure after the accident of June 9, considering that it had never before been subjected to so severe a test. All of the girder frames except one were successfully landed against the sill. This one seemed to strike an obstruction before reaching the sill and by the morning of the 10th was found so bent and warped that its wicket could not be forced down. It was therefore raised and the gap of 6½ ft. closed by 10 × 12-in. timbers placed one above the other and resting against adjacent frames. With the exception of leakage the closure was completed on the night of June 12.

For temporary repairs it is understood that there is a duplicate set of the upper lock gates on hand; if not, the upper pair of guard gates, which were undamaged, will be taken down and set up on the hinges of the upper lock gates, of which they are practically duplicates. The guard gates cannot be used in their present position because they are outside the culvert, as noted above. At the lower end of the lock the

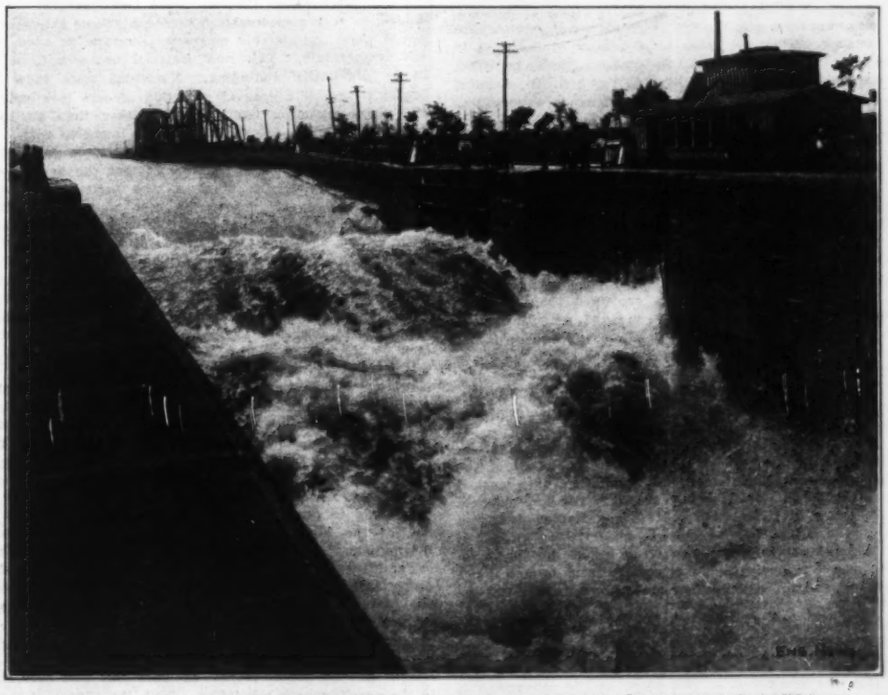

FIG. 3. VIEW OF BROKEN GATES LOOKING UP-STREAM FROM UPPER GATES.
(The nearer truss of the two seen in the background is the movable dam.)
(Copyright 1909 by Young, Lord & Rhoades.)

FIG. 4. VIEW OF LOWER LOCK GATES LOOKING UP-STREAM.
(Copyright 1909 by Young, Lord & Rhoades.)

so-called intermediate gates will be put into service in their present position. These proposed repairs are all dependent upon the condition of the sills, which, it is hoped, were not seriously damaged by the water or the boats passing over them.

Practical Aspects of Recent Improvements in Transformers.*

By W. A. LAYMAN,† M. Am. Inst. E. E.

A very great advance has been made during the last few years in the design and performance of static transformers. Much of this progress has been the result of a continuous, and, recently, quite sharp improvement in the magnetic quality of sheet steel. On this particular subject a great deal of conflicting and confusing trade literature has been published. The latest quality of transformer steel has been exploited under the various advertising names of silicon steel, alloy steel, silico-vanadium, and the like, with claims of individuality for each. They all refer to a quality of material in which the percentage of silicon has been greatly increased over that previously prevailing in the art. In chemical composition, the best material, as commonly employed in use to-day, shows the following analysis:

	New steel. %	Old steel. %
Combined carbon	0.07	0.08
Manganese	0.17	0.24
Sulphur	0.023	0.05
Silicon	3.70	0.094
Aluminum	1.314	0.05

It has been known from a very early date in the history of commercial transformers that silicon improves the quality of steel for transformer purposes, and some of the early technical writers explained the non-aging quality of impure steels, as compared with the pure, on the score of the presence of appreciable quantities of silicon. Manufacturing difficulties are said to have held back a quality of steel with as much as 3% of silicon until about two years ago, when European mills began producing successfully this high silicon material and very quickly its manufacture began here.‡

The result of this change in chemical composition, together with special heat treatment at the hands of the manufacturer of the steel, has resulted in this marked improvement in the magnetic quality. The improvement in internal energy losses of this material as compared with the old is, on the average, about 25%.

It immediately follows that transformers designed with this new material will differ greatly from former types. If the weight is left the same, performance will be greatly improved. If performance remains unchanged, the weight is largely reduced. Between these extremes there is a wide range of combinations of somewhat reduced weights, with gains also in performance.

Manufacturers at the present time are compromising between the two extremes and building transformers lessened somewhat in weight but substantially improved in performance.

A comparison of core losses of the latest high-efficiency types of the leading manufacturers, and like characteristics of the same makes as of five years ago, shows a reduction of 43% for 10-KW. size and of 48% for 50-KW. size. The copper losses are reduced 14% for the 10-KW. size and 20% for the sizes over 30 KW.

It naturally follows that this large reduction in both iron and copper losses results in greatly improved efficiency of the apparatus.

Another great advantage of this new steel, as compared with former grades, lies in the matter of aging. All manufacturers in employing the earlier grades of material were aware that even the best qualities were subject to very considerable differences. Some shipments would show considerable magnetic deterioration even at low temperature. This new material seems uniformly to be practically non-aging. Numerous tests show a tendency toward a gradual reduction of core loss under the usual operating temperatures, rather than an increase.

The cost of transformers, unfortunately, does not show the same reduction, due to the fact that the new steel costs several times as much as the earlier material. Whether this large increase in cost of material will undergo a sharp reduction as the mills become familiar with it and develop new processes of manufacture, remains to be seen. The assertion is made by the makers that present processes of manufacture are sufficiently more complicated and expensive to justify the high prices at which the steel is sold. The market price of transformers, therefore, has not been substantially modified by the advent of this new steel.

It is indicated above in general terms that with judicious use the performance may be bettered, the weight reduced, or a little of both. It is also possible with this new steel to produce a much cheaper transformer. If the transformer be designed for a density of magnetic induction above the limits considered desirable for high-grade apparatus, the labor and material cost may be considerably reduced. Such transformers will, however, be subject to pronounced and serious objection by reason of the high magnetizing current required. This magnetizing current, sometimes styled leakage or idle or no-load current, in such designs assumes abnormal proportions and is worthy of your careful notice. In the early 90's, before convenient or commercial forms of indicating wattmeters had been brought out, purchasers of transformers watched very closely the idle-current characteristics of all transformers purchased. Nearly all the manufacturers included this idle current in their performance tabulation. With the advent of the convenient portable wattmeter, data as to core losses superseded leakage current. Leakage current has consequently been almost forgotten by the purchaser. There was justification for this in that it was the prevailing practice of transformer manufacturers to keep down this leakage to very low limits.

By reason of the lower losses in the new material for a given magnetic density, it follows that in employing greater densities the losses may remain the same at reduced cost of manufacture. This high induction, however, leads inevitably to high leakage currents, and for this reason buyers should revive leakage current as a feature to be considered before making purchases. High leakage current is a dangerous thing. Under excess voltage it rises rapidly. It has been said that, since the advent of this new steel, transformers have been placed upon the market with leakage current under normal pressure running as high as 20, 25 and 50% of full-load current. In a few alleged instances of rejection this has run as high as 100%. Of course no reputable manufacturer intentionally put out any such grade of apparatus and probably nothing of this kind is being manufactured in the United States at the present time. However, the elimination of leakage current is worthy of the central station man's attention, as transformers may be supplied with actual low losses and still have very high exciting currents.

At this point it may of interest to note just what the improvement in performance characteristics of two or three sizes of distributing transformers amounts to in dollars and cents. This is shown in tabulated form, as follows:

KW.	All-Day Losses 1905 High-Efficiency Transformer Watt-Hours.	All-Day Losses 1909 High-Efficiency Transformer Watt-Hours.	Gain in Watt-Hours per Day.	Savings per Year at 1.5 Cents per KW.-Hour.
1	903	610	293	$1.60
10	4,187	2,646	1,541	8.43
50	14,415	8,760	5,655	30.96

The above calculations were made on the basis of 24 hours' core loss, 5 hours' copper loss.

The great change in physical dimensions of transformers permits of a considerable improvement in regulation, if the manufacturer or user desires it. This follows from the great reduction in copper loss it is possible to secure. As a matter of fact, however, designers of commercial transformers are not taking advantage of the possibilities in this direction, as to do so might render the new transformer incapable of operation in multiple with previous types.

Parallel operation of units of this class is a very important factor to the central station. The successful parallel operation of two or more transformers is dependent upon two factors—copper drop and reactance. The effect of these two factors in combination is usually referred to as the impedance of the transformer. Correctly speaking, transformers of the same size when operating in parallel divide their load in the inverse ratio of their impedance. Manufacturers could, therefore, with advantage to the central station, publish in their tables of data the impedance of their standard sizes. With this information before him, the user could definitely determine the division of load under parallel operation of different sizes or different makes. Those with the same percentage impedance will divide the load in proportion to their KW. capacity.

The natural effect of lower losses in present-day transformers has been to lessen the heating problem. With the reduction in physical dimensions of active parts and a lessening of the losses, smaller jackets may be employed. Conditions have so changed as to eliminate the heating question entirely in the smaller sizes; that is to say, manufacturing considerations dictate cases of such sizes that the transformers have abnormally small temperature rise.

While reduction in physical dimensions is of benefit to the user and in some ways lessens the difficulty of manufacture, it has in others increased the difficulties. It has given rise to the necessity for increased care in the internal insulation, and it is therefore wise to give most careful consideration to any existing practice that may have a tendency to impair the insulation unnecessarily. This leads to a consideration of proper insulation tests. Enough attention has not been given heretofore to the ill effects of prolonged application of test pressures, and the experimenters are now closely studying this phase of the work. These investigations are bound to result in material benefit to the manufacturer and the user. Professor A. S. Langsdorf, of Washington University, St. Louis, published some months ago a very instructive paper on the ill effects of insulation tests of long duration. He finds as the result of a long series of tests that all the ordinary insulating materials reach a condition of normal resistance to puncture within 10 seconds after an alternating pressure has been applied. This normal resistance is about one-half the instantaneous resistance. The application of test pressure beyond this interval of 10 seconds simply results in the impairment of the insulation. A given insulating material that will withstand successfully a pressure of 10,000 volts for 2 to 5 seconds may break down on that

*Parts of a paper read before the Convention of the National Electric Light Association, at Atlantic City, N. J., June 1, 1909.

†Vice-President and General Manager, Wagner Electric Manufacturing Co., St. Louis, Mo.

[‡In the discussion of this paper at the convention it was stated that the development of a silicon steel had been accomplished in this country quite independently of German efforts.—Ed.]

pressure if tested for a period of 5 minutes, and between these limits of 5 seconds and 5 minutes there is a continuous, gradual deterioration or fatigue of material. It is therefore evident that insulation tests should be limited to intervals that correspond approximately to the duration of the sudden and unusual stresses arising in the supply circuits, and it is probable that an insulation test of 10 seconds is amply sufficient to discover all the defects existing in an insulating material in this apparatus, and that a test of longer duration is not only of no benefit, but results in a gradual impairment of the insulation. In the same way an increasing frequency is shown, by Professor Langsdorf's test, to be equivalent to an increase of pressure.

Homogeneous "Double-Sealed" Road Construction.*

By FRANK LATHAM,† M. Inst. C. E.

If a method were resolved upon and systematically practiced by which the majority of roads might still be constructed of broken stone, yet indurated and rendered practically dustless, a serious grievance would be eliminated by the amelioration of the dust and dirt nuisance, and a general reduction in maintenance charges effected. The question resolves itself into a systematic restoration of worn-out road surfaces, by the substitution of improved methods of construction.

In 1899 I prepared a material, consisting of a substitute for natural asphalt, which was extensively used during that and succeeding years in Penzance and district for making pavements. It was a compound of distilled coal tar, rock pitch and lias lime, run over the surface while hot, and dusted with hot stone-breaker screenings to a thickness and rolled. Later this material was employed in making roads in hilly districts, the tar compound being used as a binder for the macadam stone. In March of 1902 the system grew to what I termed a "double-sealed" road, and it is this construction that I make special reference to in this article.

My first attempt to lay a road on this improved principle was on March 30, 1902, on a curved incline, in the busiest thoroughfare of the borough, where, as the result of heavy traction, considerable difficulty had been experienced in maintaining the road intact. I was of opinion that if I was able to render the road impervious and to provide a firmer equilibrium to the macadam by improved articulation, the road would wear better. There was no thought of a dustless road at that time; it was purely a question of durability.

Seeing that the machine-broken stone was clean and free from dust and chippings, which is not the case with hand-broken stone, unless it is screened, I conceived the idea, taken from the practice adopted in ancient times, of planting the covering stones in a bed of mortar concrete. I therefore followed up my earlier practice of grouting in the foundation with the preparation of tar compound, and upon this sealed foundation, as it now became, I laid 4 ins. of fine tar concrete, made from the screenings from the stone breaker. While this layer of tar concrete was quite loose it was sprinkled with lias lime, and the clean machine-broken stone, broken to a 2¼-in. gage, was spread over to a thickness of 3½ to 4 ins, and rolled with a 10-ton steam roller. The rolling was conducted quickly at first so as to arrange the layers, and when the road was fairly well formed some fine tar concrete was lightly thrown over the surface and brushed into the voids which remained, the whole being then rolled to completion without water.

I have laid a road of this description on an incline of 1 in 8 with the greatest of ease, and have employed it in a situation where the foundation was so weak that had I resorted to macadam and the use of water, at least the quantity of macadam stone which was used to complete the road would have been absorbed in the foundation. Rolling has been found to be reduced by the adoption of this system. The first, or foundation, seal renders the superincumbent stratum of tar concrete sufficiently mobile to work and squeeze up into the interstices of the macadam stone, hence the layers are arranged; and on completion the whole structure, from the tar blinding of the surface voids to (and into) the foundation, is rendered homogeneous, and free from any dust-producing substances. A road so made is quite waterproof, and motor wheels cannot force up the dust from under the macadam coating.

The work can be consolidated in less time by nearly 50% than it takes to roll well an ordinary watered macadam road, thus saving much grinding under the roller wheels and resulting in consequent longer life, with no powdered stone to be wafted into the atmosphere. The road is also rendered comparatively noiseless by this method of construction.

The system, in brief, is a covering of pitch compound poured into the foundation, filling up crevices and voids, and forming, with a subsequent covering of tar concrete, a waterproof stratum. The tar concrete, aided by the plastic nature of the under layer, is squeezed up into the surface covering of macadam stones, not only rendering that covering impervious but also stable under any description of traffic, by filling up the interstices and binding the surfaces of the stone together, which is further aided by the final filling of the surface voids with fine tar concrete.

It will be observed that, as no watering is required in making, the road will stand intact during dry summer weather, while it will withstand water scour, which is so destructive to macadam laid in hilly districts.

*Condensed from "The Surveyor" (London), April 23, 1909.

†Borough Surveyor of Penzance.

Notes from Engineering Schools.

UNIVERSITY OF ALBERTA.—A chair of civil and municipal engineering will be established at the provincial university, according to the decision reached by the university senate at the meeting of June 10. Professor William M. Edwards, Assoc. M. Can. Soc. C. E., will have charge of the new course.

UNIVERSITY OF WISCONSIN.—A course in public utilities and accounting will be offered at the ninth session of the summer school of the College of Engineering. The course is intended for those desiring to become familiar with the requirements of the Railroad Commission of Wisconsin, which has the administration of the Wisconsin public utilities law.

U. S. NAVAL ACADEMY.—A school of marine engineering is to be established at Annapolis for the purpose of keeping the line engineers abreast of the developments in engineering theory and practice. Ten line officers will be assigned to the school annually and will be instructed in machine design and shop administration. The superintendent of the Naval Academy will be the head of the new school.

UNIVERSITY OF ILLINOIS.—The Department of Railway Engineering, which is under Dean W. F. M. Goss, has recently installed a large drop-testing machine which is of the same design as the standard machine in the Master Car Builders' Association Laboratory at Purdue University. The machine is described as follows:

This apparatus will be used in making impact tests of such materials as car couplers, wheels, axles, etc. It consists essentially of a spring supported anvil weighing 20,000 lbs. (upon which is placed the specimen to be tested), and a hammer weighing 1,640 lbs., which runs in vertical guides rising at either side of the anvil. This hammer may be dropped in these guides from any height up to 50 ft. The addition of this machine to the existing equipment renders it possible for the University to make tension, compression, bending, and impact tests of all materials of construction, on specimens of the full size ordinarily met with in practice.

LEHIGH UNIVERSITY.—At the annual meeting of the alumni association held June 5, announcement was made of the gift to the university of a thoroughly equipped engineering testing laboratory by John Fritz, of Bethlehem, Pa. Mr. Fritz has served for over 30 years as a trustee of Lehigh University, having been one of the original trustees selected by the founder of the university. The board of trustees has appropriately recognized this gift by naming it the John Fritz Engineering Laboratory.

The formal opening of Sayre Park took place on June 5. The presentation on behalf of the children of Robt. H. Sayre was made by his oldest surviving son, John Nevin Sayre, and the park was accepted for the university by Mr. Wm. A. Lathrop, President of the Board of Trustees. The presentation exercises included an address by Prof. John L. Stewart.

RENSSELAER POLYTECHNIC INSTITUTE.—The dedication of the new building for the Schools of Mechanical and Electrical Engineering, which has been erected through the generosity of Mrs. Russell Sage, took place on Tuesday, June 15, in the presence of a large gathering of alumni and well-known engineers. Addresses were made by Hon. R. W. De Forest, of New York, Mrs. Sage's attorney and representative, and by Jesse M. Smith, of New York City, President of the American Society of Mechanical Engineers, and Lewis B. Stillwell, of New York, President of the American Institute of Electrical Engineers. Mr. Smith urged that engineering education be broadened by giving the students in one school something of the work in the other schools. At the annual commencement on the following day an address was delivered by Mr. Onward Bates, President of the American Society of Civil Engineers. The Institute enters upon a new era with the close of the 85th year of work. It now possesses three large and splendidly equipped new buildings erected within the last four years. Of the Sage gift of a million dollars, the sum of $700,000 has been reserved for a permanent endowment fund.

A PORTABLE SAW-MILL BOILER EXPLODED June 14 at Strafford, N. H. One man was killed and seven others severely injured.

AN EARTHQUAKE IN FRANCE June 12 demolished several villages in the southern part of that country and caused a loss of life which reports estimate at 100. The shock was most severe in the Departments of Herault and Bouchess du Rhone. The villages of Saint Cannat and Rognes were completely demolished and many others, including Lambesc, near Aix, suffered heavy damage.

A "SLIP" IN A BLAST FURNACE at Martin's Ferry, Ohio, June 9, caused the death of six men and the serious injury of 14 others. Reports state that 50 workmen were gathered about the furnace making ready to drill in for the nine-o'clock cast when the slip occurred and molten iron spurted from the furnace, sweeping down 20 of the men. The furnace is the property of the Wheeling Steel & Iron Co.

A TRAIN WAS BLOWN OFF A BRIDGE during a tornado in the Texas panhandle on June 10. The storm was quite extensive, and did great property damage, besides killing about a dozen persons. A passenger train on the Kansas City, Mexico & Orient Ry., while crossing a bridge or trestle over the dry bed of the upper Brazos, near Sweetwater, was blown off and fell ten feet to the creek bed. One passenger was killed.

FOREST FIRES IN MAINE AND CANADA during the past week have devastated many thousand acres of forest land. The hamlet of Hillmans in northeastern Maine was destroyed by the fire June 11, but the 50 inhabitants escaped unharmed on a special relief train. On the same date the settlement in New Brunswick known as Couillard & Guimonts Mills was entirely consumed. Forest fires are reported in nearly every county of the Province of New Brunswick and lesser fires are burning in Quebec and Nova Scotia.

HEAVY RAINFALL IN SOUTH DAKOTA during the last week in May caused considerable damage to dams, highway bridges and railway road-beds. The towns of Lead and Deadwood were entirely cut off from railway communication by extensive washouts.

At Diagonal, Iowa, June 8, the passengers on train No. 6 on the Chicago Great Western Ry. were driven to the car roofs by the rapidly rising waters and were eventually rescued by boats. While train No. 6 was waiting on a siding for train No. 3, the waters of the Grand River, reports state, rose to a depth of 7 ft. above the road-bed, flooding the coaches.

ORVILLE AND WILBUR WRIGHT, inventors of the most successful aeroplane, recently received gold medals from the Aero Club of America in recognition of their success. The presentation was made by President Taft at the White House, Washington, D. C., on June 10. The trials of the aeroplane, which the Wright Brothers are under contract to deliver for the Signal Corps of the U. S. Army and which were interrupted in September, 1908, by an accident which wrecked the flyer and killed Lieut. Thomas Selfridge of the Signal Corps, will be resumed at Fort Meyer in another week.

PANAMA CANAL EXCAVATION during May was 2,896,095 cu. yds. against 3,454,649 cu. yds. in the previous month. The average daily output for the 25 working days of May was 115,844 cu. yds. as against 138,186 cu. yds. for the 25 working days in April. Rainfall in May was 9.82 ins., in April 4.36 ins.

The amount of concrete laid during May was 11,586 cu. yds. against 7,978 cu. yds. in the previous month and 366,677 cu. yds. of fill were placed in dams against 328,903 cu. yds. in April.

TRAFFIC THROUGH THE SUEZ CANAL showed a falling off in 1908 from 1907, as a result of the world-wide depression in business. Last year 3,795 vessels, representing 13,633,283 tons net, passed through the canal. This was a decrease of 472 vessels and 1,095,151 tons from the record of 1907. The average size of the vessels using the canal continued to increase, being 3,592 tons in 1908 against 3,452 tons in 1907. The average time of passage through the canal, 17 hrs. and 24 mins., was the best average since the canal was opened. The total receipts of the canal company for 1908 amounted to 111,491,000 francs, a falling off of about 8,600,000 francs from 1907. The expenses of op-

eration, however, amounted to nearly 45,000,000 francs, leaving a balance of net earnings amounting to 66,578,000 francs. The capital cost of the canal at the end of 1908 was 633,548,000 francs.

ACCIDENT STATISTICS FOR PENNSYLVANIA, as compiled by the state railway commission, show that, during the first three months of the present year, 37 persons were killed and 765 injured on the electric railways in that state. Only three of the persons killed were passengers.

FRENCH AEROPLANE MOTORS.—The "London Times" of June 2 gives in its engineering supplement data on the principal gasolene motors, used in French aeronautic experiments, from which the following table is arranged:

Motor.	Aeroplane.	Cylinders. Number.	Size.*	Weight, lbs.	R. p. m.	H P.
Antoinette	Antoinette, Delagrange, Farman, Moore-Brabazon	8 inclined, water-cooled	4.14 / 4.14	154	1400	50† 55
Anzai	Vendôme	3	5.32 / 5.92	227	1400	50† 34
Clerget	Tatin-Clement-Bayard	7 star, water-cooled	3.94 / 4.53	.....	1200	50† 34
Dutheil & Chalmers	Santos-Dumont	4 horizontal, water-cooled	4.93 / 4.73	288	1400	58† 39
Esnault-Pelterie	.....	10 fan, air-cooled	3.15 / 3.74	.....	1500	35† 28
Breguet	Gobron	8 cross, water-cooled	3.55 / 6.31	331	1500	80†
Gnome	.....	7 revolving-star, air-cooled	3.94 / 4.73	165	1200	50† 43
Pipe	.....	8 inclined, air-cooled.	3.94 / 3.94	289	1600	70† 50

*The numerator expresses cylinder bore and the denominator stroke, both in inches.
†The first figure quoted is claimed performance, the second is rated from dimensions by rules of the Royal Automobile Club.

EXPLOSIVES FOR COAL MINES are being tested by the Technologic Branch of the U. S. Geological Survey at its Explosives Testing Station at Pittsburg, Pa. Already 29 brands have been tested, and 17 of these met all the tests specified for "permissible explosives." The tests comprise: (1) Ten shots into air containing 8% methane and ethane; (2) ten shots into air containing 4% methane and ethane and 20 lbs. coal dust; (3) ten shots into air containing 40 lbs. coal dust, half of which is placed on a horse in front of the firing cannon; these three tests being made with charges equivalent to ½-lb. of 40% dynamite, the second test is then repeated (4) with increasing charges up to 1½ lbs., to determine the limiting safe charge. A list of the explosives which passed these tests may be obtained from the Survey.

Some useful memoranda on the subject of "safety explosives" are given by the Survey in this connection, as follows:

With equal quantities of each, the flame of black powder is more than three times as long and has a duration 3,000 to more than 4,000 times that of one of the permissible explosives; also the rate of explosion is slower.

The permissible explosives are 1¼ to 1¾ times as strong and are said, if properly used, to do twice the work of black powder in bringing down coal; hence only half the quantity need be used.

With 1 lb. of a permissible explosive or 2 lbs. of black powder, the quantity of noxious gases given off from a shot averages approximately the same, the quantity from the black powder being less than from some of the permissible explosives and slightly greater than from others. The time elapsing after firing before the miner returns to the working face or fires another shot should not be less for permissible explosives than for black powder.

The use of permissible explosives should be considered as supplemental to and not as a substitute for other safety precautions in mines where gas or inflammable coal dust is present under conditions indicative of danger. They should not be used with strong detonators; the charge should not exceed 1½ lbs. and in many cases should not exceed 1 lb.

Inasmuch as no explosive manufactured for use in mining is flameless, and as no such explosive is entirely safe under all the variable mining conditions, the use of the terms "flameless" and "safety" as applied to explosives is likely to be misunderstood, may endanger human life, and should be discouraged.

THE ECONOMIC SUPERIORITY OF PARTIAL width arch ribs carrying the roadway on a connecting slab over the full-width arch ribs in long-span masonry arches is now generally conceded. This superiority is due to the fact that in the former the ratio of live to dead loads is much smaller and the stresses in the masonry ribs is much more nearly equal the safe limit of the material. In addition there is also a great saving of material because a light, cheap reinforced-concrete slab takes the place of heavy costly masonry for a large part of the arch width. In the falsework, too, the possibility of the reuse of the centering, which is much lighter than under a full width arch, effects a saving.

The above statements, with the exception of those relating to the falsework, are proved by a table of stresses which was prepared some time ago by M. Sejourne, of the French Ponts et Chaussees, well known in this country as the designer of the Luxembourg and other large masonry arches in France. The data are on the main arches of the masonry bridge across the Garonne River at Toulouse, France. These arches are 150.9 ft. span, and, as built, are of two stone arch ribs, each 10.7 ft. wide and 41.8 ft. c. to c., carrying on a connecting slab a 43.3 ft. roadway, flanked on either side by a 14.4 ft. sidewalk. As originally designed the arches had a solid stone arch ring 52.5 ft. wide. The accompanying table gives relative data on the two designs. The solid arch was estimated to cost $240,000; the double arch was estimated at and cost $180,000.

TABLE OF STRESSES IN SINGLE AND DOUBLE ARCH-RING DESIGN IN TOULOUSE BRIDGE, FRANCE.

	Mean Unit Stresses in lbs. per sq. in.					
	Double Arch Ring as Built.		Single Arch Ring as Designed.		Per cent. of Live Load to Total.	
	Dead load.	Dead + live.	Dead load.	Dead + live.	Double ring.	Single ring.
Key	304	336	240	254	9.7	5.0
Haunch ..	160	172	143	150	8.0	4.7
Spring ...	65	69	92	96	6	4.4
Foundation	65	66	88	90	3.0	2.6

It will be noted that the mean stress at the crown is increased from 254 to 336 lbs. per sq. in. and that the percentage of live to dead is increased from 5 to nearly 10%, both tending toward a more economical design.

THE WORLD'S GOLD PRODUCTION, according to the "Statistical Abstract of the United States," to be issued by the Department of Commerce and Labor, aggregates, from the discovery of America to the present time, thirteen billion dollars. The amount of this gold now in existence is estimated at eleven billion dollars, of which seven billions are in the form of gold coin, three billions being in circulation, and the remaining four billions in banks and public treasuries.

Personals.

Capt. J. M. Bowyer, U. S. N., has succeeded Capt. Chas. J. Badger as Superintendent of the Naval Academy at Annapolis.

Mr. C. H. Hix, General Superintendent of the Seaboard Air Line Ry., will succeed Mr. W. A. Garrett as Chief Executive Officer of that railway on June 30.

Mr. H. E. Gilpin, Superintendent of the Delaware & Hudson Ry., at Carbondale, Pa., has resigned and will be succeeded by Mr. C. E. Burr, Trainmaster at Oneonta, N. Y.

Mr. Jay Downer, formerly Engineer of the Scarsdale Co., Scarsdale, N. Y., has become Engineer of the Island Cities Real Estate Co., with offices in Brooklyn, N. Y.

Mr. Howard A. Carson, M. Am. Soc. C. E., has resigned his position as Chief Engineer of the Boston Transit Commission. Reports state that he intends to devote himself for a time to travel and study.

Mr. Walter R. Duckworth, Assoc. M. Can. Soc. C. E., for twelve years Chief Inspector for the Dominion Bridge Co., has opened an office in the Eastern Townships Bank Bldg., Montreal, Que., as an inspecting engineer.

Mr. William L. Derr, of New York City, has been appointed Inspector in the division of transportation by the New York Public Service Commission, Second District, to succeed Mr. Edmund F. Van Hoesen, M. Am. Soc. C. E.

Mr. Chas. R. McKay, Assoc. Am. Inst. E. E., has resigned his position as Manager of the Light and Power Department of the Toledo Railway & Light Co. to become General Manager of the Union Light, Heat & Power Co., of Covington, Ky.

Mr. Alfred E. Forstall, M. Am. Soc. M. E., of New York City, has been elected Honorary Alumni Trustee of Lehigh University. Mr. Forstall graduated at Lehigh in the class of 1891. He has since been engaged in gas engineering; first in the operation of works and for some years past as consulting engineer and as expert in valuation and rate-fixing cases. For a number of years he was Secretary of the American Gas Light Association.

Mr. Ernest F. Nichols, Professor of experimental physics at Columbia University, has been elected President of Dartmouth College to succeed Mr. W. J. Tucker, who has resigned on account of ill health. Mr. Nichols received the degree of B. S. at the Kansas Agricultural College in 1888 and was afterward a graduate student at Cornell University, where he received the degrees of M. S. in 1893 and of D. Sc. in 1897. Before becoming a member of the faculty of Columbia University, he was Professor of Physics (1898-1903) at Dartmouth.

Obituary.

Joseph N. Nimmo, who was for ten years Chief of the U. S. Bureau of Statistics, died June 15 at his home in Washington, D. C., as the result of a stroke of paralysis. Mr. Nimmo was born in 1830 and has resided in Washington for the past 50 years.

Victor O. Friday, President of the Friday Construction Co., was struck on the head and killed by a broken derrick boom, June 9, while superintending the construction of the bridge across the Allegheny River, near Oakland, Allegheny Co., Pa. Mr. Friday was born at Pittsburg, Pa., in 1876.

Lucien N. B. Wyse, a French engineer, died June 15 at Toulon, France, aged 64 years. Mr. Wyse, as the head of the association entitled "Societe civile Internationale du Canal Interoceanique," obtained from the Columbian Government in May, 1878, the concession for the French Panama Canal.

Daniel Murphy, First Assistant to the Chief Engineer of the new Meteo Valley R. R., was killed June 12 by lightning at the construction camp near Carlisle, Ark. Two rodmen who were in the same tent with Mr. Murphy were instantly killed with him, and four others in the tent, though not killed outright, died later from the injuries received.

Robert B. Lincoln, M. Am. Soc. M. E., died June 15 at his home in Waltham, Mass., aged 64 years. Mr. Lincoln was educated in the public schools of Boston, Mass. He entered the U. S. Navy in 1861 and served continuously until the close of the Civil War, when he was mustered out and became Chief Draftsman of the Portsmouth Navy Yard. At the time of his death he was President of the Waters Governor Co., with which he had been associated for the past 30 years.

Engineering Societies.

COMING MEETINGS.

MASTER CAR BUILDERS' ASSOCIATION.
June 21-23. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
June 21-23. Annual meeting at Chicago, Ill. Secy., D. B. Sebastian, C. & E. I. R. R., 327 La Salle Station, Chicago, Ill.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
June 23-25. Annual meeting at Detroit, Mich. Secy., P. W. Drew, Wisconsin Central Ry., Chicago, Ill.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 24-26. Semi-annual meeting at New York City. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 24-26. Annual convention in New York and Brooklyn. Secy., Arthur L. Williston, Pratt Institute, Brooklyn, N. Y.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
June 24-26. Summer convention at Detroit, Mich. Secy., Wm. J. Baxter, 29 W. 39th St., New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 28. Annual convention at Frontenac, N. Y. Secy., Ralph W. Pope, 33 West 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 29-July 3. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.
July 5-9. Annual meeting at Seattle, Wash. Secy., A. H. Dimock, City Hall, Seattle, Wash.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
July 6-9. Annual convention at Bretton Woods, N. H. Secy., Chas. W. Hunt, 220 West 57th St., New York City.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 13-15. Annual convention at Toledo, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 15-16. Summer meeting at Indianapolis, Ind. Secy., W. M. Mackay, P. O. Box 1818, New York City.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION.—The date of the annual convention, formerly announced as Oct. 18-22, has been changed to Oct. 4-8. The convention will be held at Denver, Colo.

NEW ENGLAND WATER WORKS ASSOCIATION.—The June field day was celebrated June 16 by an excursion down Boston Harbor and to Bass Point, Nahant. The party stopped at Deer Island to visit the Metropolitan Sewerage Pumping Station. The annual convention will be held Sept. 8-10 in New York City.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.—The sessions of the summer convention at Detroit, Mich., June 24-26, will be held in the Stevens Building. Sessions for the reading and discussion of papers will be held in the forenoons of June 25 and 26. On the opening day of the convention there will be an excursion to the plant of the American Shipbuilding Co., at Wyandotte, where a launch will take place.